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Aeronautical Engineering
A Continuing Bibliography with Indexes

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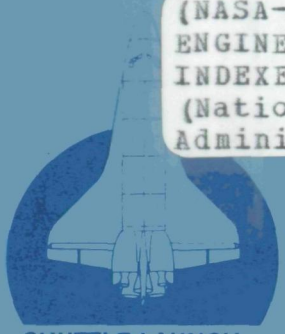

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Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

STAR (N-10000 Series)	N80-28295 – N80-30271
IAA (A-10000 Series)	A80-43839 – A80-47366

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AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 128

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in October 1980 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 419 reports, journal articles, and other documents originally announced in October 1980 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

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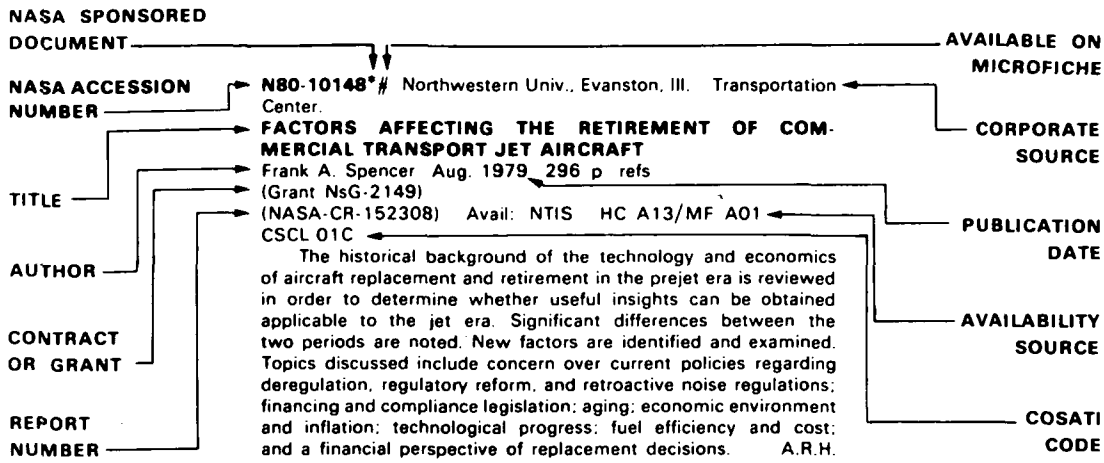

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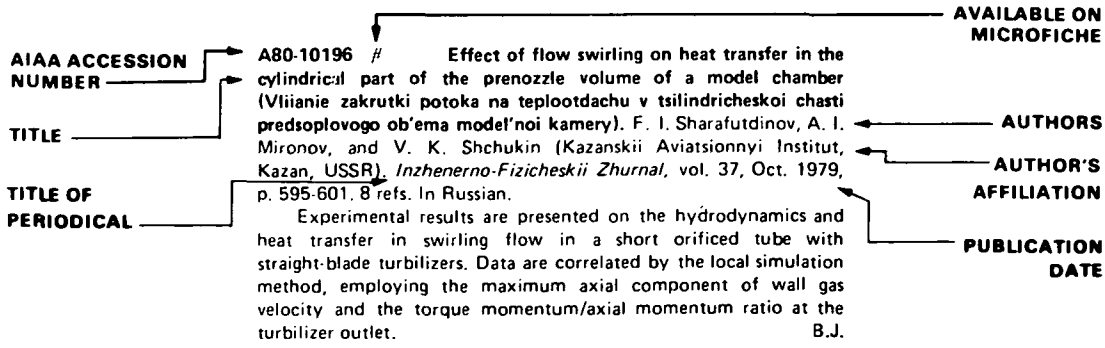

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 128)

NOVEMBER 1980

IAA ENTRIES

A80-44109 # **Propeller proplet optimization based upon analytical and experimental methods.** K. L. Irwin and R. Mutzman (Ohio State University, Columbus, Ohio; Boeing Co., Seattle, Wash.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 16th, Hartford, Conn., June 30-July 2, 1980, AIAA Paper 80-1241.* 28 p. 10 refs.

The use of proplets to modulate the radial load distribution on a propeller has been proposed as a means of increasing the efficiency of a propeller. A theoretical and exploratory experimental study was undertaken to determine the advantages/disadvantages of proplets versus a baseline propeller; i.e., without proplets. Propeller efficiency, thrust, torque, and power coefficients were examined theoretically using vortex theory for propellers with and without proplets. Scaled propellers of approximately seventeen inches in diameter were utilized in an exploratory experimental study of proplets using the propeller test rig at The Ohio State University - a segment of the study still in progress. (Author)

A80-44110 **ICAA Zagreb meeting.** *Airport Forum,* vol. 10, June 1980, p. 13, 14, 17-19.

Various concerns regarding airports are discussed, including the problems of small and regional airports, and situations where suburban airports are underoccupied due to the presence of an airport near the city center such as at Milan-Linate. The airport/airline relationship concerning airport fees and allied costs is also considered as well as dispatching and ramp operations with regard to handicapped people. Attention is given to increased dispatching productivity resulting from the centralization of services, and to the possibility of unified tariff structures. In addition, fuel, efficiency, surface transportation to, from and around airports, and the airport/environment relationship are considered. J.P.B.

A80-44111 **New turnoffs for 'optimum runway occupancy times'.** I. H. Carr (Dade County, Aviation Dept., Miami, Fla.), P. Reaveley, and L. B. Smith (Howard Needles Tammen and Bergendoff, Architects, Engineers and Planners, Miami, Fla.). *Airport Forum,* vol. 10, June 1980, p. 21-23, 26.

The optimization of runway turnoffs and terminal apron taxiways as an integral system at Miami International Airport is discussed. The new runway turnoffs are aimed at achieving, at reasonable speed, comfortable but consistent runway occupancy times of 45 to 55 seconds for narrow-body aircraft and 50 to 55 seconds for wide-body aircraft. Attention is given to the optimum points to begin turning off the runway centerline for commuter aircraft, B-727s and widebody aircraft, as well as to operational requirements of the marking and lighting of the turnoffs and to the grading of the turnoffs. J.P.B.

A80-44113 **Airport desires and needs concerning noise levels and handling of new transport aircraft.** D. R. A. Stapel (Amsterdam, Schiphol, Amsterdam, Netherlands). *Airport Forum,* vol. 10, June 1980, p. 42, 44.

The abatement of aircraft noise at the source is discussed within the framework of uniform, worldwide regulations for the present and future. Attention is given to noise from auxiliary power units, from engine thrust reversal and from the airframe, expecially in the approach configuration. In addition, the development of low-noise engines, which has been assisted by stringent regulation of various governments and the necessity of improved, more fuel-efficient and quieter engines due to increasing fuel price, is considered. The handling of new aircraft so that it is compatible with existing facilities is also discussed. J.P.B.

A80-44114 * **Advanced transport aircraft technology.** R. L. Winblade (NASA, Transport Aircraft Office, Washington, D.C.). *Airport Forum,* vol. 10, June 1980, p. 44-48, 50.

Various elements of the NASA aircraft energy efficiency program are described. Regarding composite structures, the development of three secondary and three medium-primary components to validate structural and fabrication technology is discussed. In laminar flow control, the design of advanced airfoils having large regions of supercritical flow with features which simplify laminarization are considered. Emphasis is placed on engine performance improvement, directed at developing advanced components to reduce fuel consumption in current production engines, and engine diagnostics aimed at identifying the sources and causes of performance deterioration in high-bypass turbofan engines. In addition, the results of propeller aerodynamic and acoustic tests have substantiated the feasibility of achieving the propeller efficiency goal of 80% and confirmed that the effect of blade sweep on reducing propeller source noise was 5-6 dB. J.P.B.

A80-44115 **BARCIS - A new lighting control system for Gatwick.** *Airport Forum,* vol. 10, June 1980, p. 58, 59.

The British Airports Rapid Control and Indication System (BARCIS) for controlling airport lighting is described. For both the air traffic and ground movement controllers, BARCIS is a panel which presents a schematic diagram of the runways, taxiways and the lighting associated with these installations. Once the air traffic controller has determined the proper route for an aircraft departing or entering the runway, he punches in this route on his BARCIS panel, giving the pilot his own row of continuous lights to follow. Routing of the aircraft is simplified by grouping and dividing taxiway sections into traffic blocks with their own centerline lights. Attention is given to the miniaturization and speed advantages of the BARCIS system. J.P.B.

A80-44116 **Environment-compatible and economic airport drainage.** H. G. Haendschke (Frankfurt Flughafen, Frankfurt am Main, West Germany). *Airport Forum,* vol. 10, June 1980, p. 61-64.

The drainage requirements of airport areas are discussed, and the expanding Frankfurt airport with an average annual amount of precipitation on the airport's area of approximately 0.65 cu m/sq m, is taken as an example. Attention is given to the drainage process which works on the basis of the separation principle. Domestic waste

water, rainwater, and oil and fuel contaminated aircraft wash water, which is a stable emulsion which cannot be separated chemically or mechanically, are considered. It is recommended that the dimensions of the channel system upstream of the retention tank be calculated on the basis of the average amount of rainwater collected in 10, rather than the generally used (in Frankfurt construction) 15 minutes, on an area of one hectare; the advantage is that the volume of the main collectors can be added to the calculated volume of the retention basins. J.P.B.

A80-44117 Airport equipment and know-how from England - An airport forum survey. *Airport Forum,* vol. 10, June 1980, p. 65, 67, 68 (12 ff.).

Various products and services for use in airports are described, including consulting services with regard to aeronautical communications, radar, meteorology and security procedures. Emphasis is placed on ground vehicles: aircraft towing tractors, baggage conveyors, work platforms and transporters are discussed. In addition, cargo handling systems, visual control rooms, and fire, crash and rescue vehicles, including foam crash tenders, are considered. J.P.B.

A80-44132 * # Numerical simulation of three-dimensional boattail afterbody flow fields. G. S. Deiwert (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1347.* 12 p. 30 refs.

The thin shear layer approximations of the three-dimensional, compressible Navier-Stokes equations are solved for subsonic, transonic, and supersonic flow over axisymmetric boattail bodies at moderate angles of attack. The plume is modeled by a solid body configuration identical to those used in experimental tests. An implicit algorithm of second-order accuracy is used to solve the equations on the ILLIAC IV computer. The turbulence is expressed by an algebraic model applicable to three-dimensional flow fields with moderate separation. The computed results compare favorably with three different sets of experimental data reported by Reubush, Shrewsbury, and Benek, respectively. (Author)

A80-44141 * # A multi-grid code for 3-D transonic potential flow about axisymmetric inlets at angle of attack. D. R. McCarthy (Indiana University; Purdue University, Fort Wayne, Ind.) and T. A. Reyhner (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1365.* 8 p. 5 refs. Grant No. NsG-1635.

In the present work, an existing transonic potential code is adapted to utilize the Multiple Level Adaptive technique proposed by A. Brandt. It is shown that order of magnitude improvements in speed and greatly improved accuracy over the unmodified code are achieved. Consideration is given to the difficulties of multi-grid programming, and possible future applications are surveyed. M.E.P.

A80-44142 * # Calculations of transonic flow about an airfoil in a wind tunnel. L. S. King and D. A. Johnson (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1366.* 12 p. 28 refs.

A combined experimental and numerical study was performed to include wind-tunnel wall interference effects in calculations for airfoil flows at transonic speeds. Pressure-survey-tube and laser-Doppler velocimeter measurements were made in the flow field about an airfoil in the 2- by 2-Foot Transonic Wind Tunnel at Ames Research Center. The results were then used as boundary data in a Navier-Stokes code modified by incorporating a pressure condition on the upper and lower computational boundaries. Comparison of calculated results and experimental data obtained from the surface of the airfoil indicates that the pressure-boundary condition is particularly effective in moving the shock to a position near that observed experimentally when the flow remains attached. For flows with large separation, shock position and viscous-layer properties are not well predicted, principally because of the inadequacies of the algebraic turbulence models employed with the method. (Author)

A80-44143 # Numerical solution of three-dimensional unsteady transonic flow over swept wings. C. J. Borland, D. P. Rizzetta, and H. Yoshihara (Boeing Military Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1369.* 12 p. 24 refs. Contract No. F33615-78-C-3201.

An algorithm for the calculation of unsteady transonic flow over three-dimensional swept wings undergoing general unsteady motion has been developed. The equation considered is the transonic small disturbance potential equation with second order terms to ensure proper swept shock jump conditions. An approximate factorization implicit difference scheme is employed. A shearing transformation of the coordinates is applied in order to map a swept tapered planform onto a rectangle in the computational domain. Use of a rotated type-dependent differencing scheme provides computational stability as well as proper shock capture. Computed results for an infinite yawed wing are found to agree with two-dimensional solutions when simple sweep theory is applied for both the steady and unsteady cases. Steady three-dimensional results compare favorably with existing steady methods. Unsteady results are presented for a swept wing undergoing sinusoidal pitching motion at M = 0.9. It is found that the shock position oscillates over about 16% of chord at the wing tip. (Author)

A80-44149 # Computational transonic inverse procedure for wing design with automatic trailing edge closure. V. Shankar (Rockwell International Science Center, Thousand Oaks, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1390.* 12 p.

A computational transonic inverse procedure for three-dimensional wings in which shapes are determined supporting prescribed pressures, is presented. The method is based on the modified small disturbance (MSD) theory and can handle wing design in the presence of a fuselage. A consistent analysis-inverse differencing is implemented at the wing slit grid points to ensure recovery of specified pressures in the analysis mode. Formation of an open or a fishtail trailing edge is avoided by a systematic alteration of the velocity potential in front of the leading edge of span stations under inverse mode, until closure is achieved. Development of a laminar flow control (LFC) wing from a given base wing made up of nearly NACA four digit airfoils is presented along with analysis check and off-design calculations. (Author)

A80-44150 # Grid generation and transonic flow calculations for three-dimensional configurations. N. J. Yu (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1391.* 8 p. 14 refs. Research supported by the Boeing Independent Research and Development Program.

A newly developed grid generation technique together with a transonic flow analysis algorithm for three-dimensional configurations is presented in this paper. The grid generation method utilizes Thompson's body-fitted coordinate approach to produce a smooth and well-distributed computational grid system. The flow analysis algorithm uses the Jameson-Caughey finite volume method to solve the full potential equations in conservation form. Convergence acceleration based on an extrapolation method is used to improve the computational efficiency. Numerical results for a transport wing-body configuration are compared with test data. Significant improvements over wing-alone calculations in the prediction of wing surface pressures have been achieved with the new code. (Author)

A80-44151 * # Asymmetric trailing-edge flows at high Reynolds number. J. W. Cleary, C. C. Horstman, H. L. Seegmiller

(NASA, Ames Research Center, Moffett Field, Calif.), and P. R. Viswanath (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1396*. 17 p. 25 refs.

Results from an experimental investigation of asymmetric trailing-edge flows at high Reynolds numbers and subsonic Mach numbers are presented. Measurements include skin friction; surface and flow-field pressures; and mean-velocity, turbulent shear-stress, and turbulent kinetic-energy profiles in the trailing-edge region. Comparisons are made with computed solutions using Reynolds averaged Navier-Stokes and boundary-layer equations; two different turbulence models are used. Two attached flow are considered, one having a moderate adverse pressure gradient and the other a more severe gradient. From the comparisons, an evaluation is made of the predictions for these two pressure-gradient cases. Although the comparisons demonstrate reasonable agreement for the moderate pressure-gradient case, some differences are noted for the severe pressure-gradient case. (Author)

A80-44152 # **Experimental and analytical evaluation of 3-dimensional exhaust plumes.** F. P. Saheli (Boeing Aerospace Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1399*. 7 p. 6 refs.

An experimental and analytical study was conducted to investigate exhaust plume development of two rectangular nozzles of aspect ratios 4 and 10 and one circular nozzle. The test and the analysis were carried out for these plumes with and without mixed streams upstream of the nozzle exit. Initial flow properties were defined to simulate turbofan engine operation. A three-dimensional viscous flow computer program with two equation turbulence model was used to predict exhaust plume temperature and velocity profiles downstream of nozzle exit. Total pressure and total temperature surveys were measured with a traversing rake at four locations downstream of the nozzle exit. Results of the analysis in terms of nozzle exhaust plume total temperature and velocity profiles are compared with results from the experiment. (Author)

A80-44158 * # **Controlled supercritical crossflow on supersonic wings - An experimental validation.** W. H. Mason (Grumman Aerospace Corp., Aerodynamics Section, Bethpage, N.Y.) and D. S. Miller (NASA, Langley Research Center, High Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1421*. 16 p. 13 refs. Contract No. NAS1-15351.

Leading edges of wings with high lift at supersonic speeds are discussed. Under these conditions, the leading edge must generate a controlled supercritical crossflow such that high lift is obtained without boundary layer separation. The leading edge concept that accomplishes this is the supersonic counterpart of the leading edge of the 2-D supercritical airfoil at transonic speeds. Wind tunnel test results on a cambered wing with a controlled supercritical crossflow leading edge successfully validated the concept. The main results are presented at the M = 1.62 design point, with off-design results given for the range of Mach numbers from 1.60 to 2.00. Surface pressure, oil flow photographs, and force data are presented and analyzed. A flat wing with the same thickness distribution was also tested and the results were used both for comparison with the designed wing and to illustrate the development of the supercritical crossflow region which, for the flat wing, is terminated by a distinct crossflow shock wave. (Author)

A80-44159 # **Flow studies of slender wing vortices.** G. E. Erickson (Northrop Corp., Aircraft Group, Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1423*. 31 p. 39 refs.

Vortex flows emanating from the leading edge of slender and hybrid (wing/leading-edge extension /LEX/) wing geometries can result in increased maximum lift, drag reductions at high lift, and can strongly influence the longitudinal and lateral-directional stability characteristics in the extended angle-of-attack regime. Furthermore, controlled leading-edge separation on slender wing designs featuring suitable surface curvatures is a promising means of maintaining large amounts of vortex-induced lift while reducing the attendant 'vortex drag' associated with the loss of leading-edge thrust due to flow separation at the leading edge. Northrop has conducted in-depth flow visualization studies in a hydrodynamic facility of slender wing leading-edge vortex flow characteristics up to high angles of attack and sideslip. Vortex stability and vortex core trajectory characteristics have been obtained on planar and nonplanar delta and delta-related planforms and wing-LEX geometries. The effects of leading- and trailing-edge flap arrangements, planform contouring, wing apex and tip modifications, and vertical tail location on vortex stability are discussed. Where appropriate, correlation is made with subsonic wind tunnel data. (Author)

A80-44230 * # **JT9D-7A /SP/ jet engine performance deterioration trends.** G. P. Richter (NASA, Lewis Research Center, Cleveland, Ohio), W. J. Olsson (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.), and N. B. Andersen (Pan American World Airways, Inc., Kennedy International Airport, N.Y.). *Hamilton Burr Publishing Co., International Aircraft Maintenance Engineering Exhibition and Conference, Dallas, Tex., Apr. 8-10, 1980, Paper.* 21 p.

It is noted that increasing fuel costs and the decreasing availability of fuel supplies have lead to an increase in the importance of maintaining good specific fuel consumption over the life cycle of jet engines. Attention is given to an engine diagnostics program sponsored by NASA Lewis Research Center which has the objectives of identifying and quantifying the levels, trends, and causes of engine performance deterioration. It is reported that as part of the program, a series of installed engine calibrations were performed on two new Pan American World Airways 747 SP aircraft. A discussion of this specific test program and the results of the analysis of the data are presented. M.E.P.

A80-44232 * # **Microwave radiometric aircraft observations of the Fabry-Pérot interference fringes of an ice-water system.** R. F. Harrington, C. T. Swift, and J. C. Fedors (NASA, Langley Research Center, Hampton, Va.). *COSPAR and Inter-Union Commission on Radio Meteorology, Symposium on Oceanography from Space, Venice, Italy, May 26-30, 1980, Paper.* 8 p.

Airborne stepped-frequency microwave radiometer (SFMR) observations of the Fabry-Pérot interference fringes of ice-water systems are discussed. The microwave emissivity at normal incidence of a smooth layered dielectric medium over a semi-infinite dielectric medium is examined for the case of ice over water as a function of ice thickness and attenuation coefficient, and the presence of quarter-wavelength oscillations in emissivity as the ice thickness and frequency are varied is pointed out. Experimental observations of pronounced quarter-wavelength oscillations in radiometric brightness temperature due to the Fabry-Pérot interference fringes over smooth sea ice and lake ice varying in roughness as the radiometer frequencies were scanned are then presented. A.L.W.

A80-44240 * # **Application of superalloy powder metallurgy for aircraft engines.** R. L. Dreshfield and R. V. Miner, Jr. (NASA, Lewis Research Center, Cleveland, Ohio). *Metal Powder Industries Federation and American Powder Metallurgy Institute, International Powder Metallurgy Conference, Washington, D.C., June 22-27, 1980, Paper.* 19 p. 8 refs.

The results of the Materials for Advanced Turbine Engines (MATE) program initiated by NASA are presented. Mechanical properties comparisons are made for superalloy parts produced by as-HIP powder consolidation and by forging of HIP consolidated billets. The effect of various defects on the mechanical properties of powder parts are shown. V.T.

A80-44267 **Pattern shaping with a metal plate lens.** A. C. Brown, Jr. (Goodyear Aerospace Corp., Litchfield Park, Ariz.). *IEEE Transactions on Antennas and Propagation*, vol. AP-28, July 1980, p. 564-568. 10 refs.

The paper presents the design of a shaped beam microwave antenna using a metallic parallel plate lens to provide the shaping. The Woodward-Levinson technique is applied to transform the pattern requirement into a suitable aperture distribution. Initial plate positions and lengths of the lens are determined from geometrical optics and infinite waveguide theory. V.T.

A80-44435 **Supercavitating hydrofoils with wetted upper sides.** A. Rowe and J.-L. Kueny (Grenoble, Institute de Mécanique, Grenoble, France). *Journal de Mécanique*, vol. 19, no. 2, 1980, p. 249-294. 24 refs. Direction des Recherches et Moyens d'Essais Contracts No. 75/297; No. 76/298.

This paper aims to give the characteristics of a supercavitating hydrofoil with a wetted upper side and a rounded leading edge placed in a shallow tunnel with a rapid flow running through it. The method used is a perturbation method expanded in relation to a single small parameter characterising at one and the same time the thickness of the foil, its incidence and the depression of the cavity. The use of a single small parameter leads to a consistent formulation making it possible, if required, to take the gravity effects into account, assuming the flow to be supercritical. The cavity wake is considered by introducing a displacement surface with a set pressure condition on its boundaries. Apart from the closed contour formed by the foil, its cavity and the displacement surface, the flow is assumed to be irrotational and the fluid inviscid. The calculations have been developed only in the case of free gravity fluid. The extension to the case of fluid with gravity will be set out in another paper. The foil used for the calculations has been the subject of a certain number of tests which are described in the second part of the present study. (Author)

A80-44491 * # **Prediction of unsuppressed jet engine exhaust noise in flight from static data.** J. R. Stone (NASA, Lewis Research Center, Jet Acoustics Branch, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 6th, Hartford, Conn., June 4-6, 1980, Paper 80-1008*. 24 p. 22 refs.

In order to assess the impact of aircraft noise on the environment in the vicinity of an airport, it is essential that a methodology be developed for predicting in-flight exhaust noise from static data. Such a methodology is presented in this paper and is compared with experimental data for several unsuppressed turbojet engines. For each engine, static data over a range of jet velocities are compared with the predicted jet mixing noise and shock-cell noise. The static engine noise over and above the jet and shock noises is identified as 'excess' noise. The excess noise data are then empirically correlated to smooth the spectral and directivity relations and account for variations in test conditions. This excess noise is then projected to flight based on the assumption that the only effects of flight are a Doppler frequency shift and a level change. The effects of flight on jet mixing noise and shock noise are computed by published NASA methods. (Author)

A80-44514 **Acousto-optic devices for use in radio frequency target simulators.** E. K. Kirchner (Teledyne MEC, Palo Alto, Calif.). In: Active optical devices; Proceedings of the Seminar, San Diego, Calif., August 27, 28, 1979. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1980, p. 175-179. 10 refs.

It is noted that acousto-optic devices have been analyzed and developed for use as modulators, filters and correlators, and in spectrum analyzers. Attention is given to the application of acousto-optic devices for the simulation of moving targets to test fuzing altimeters and active missile control systems. It is shown that the frequency modulation, amplitude modulation, and deflection properties of acousto-optic components are all utilized in a single acousto-optic unit to provide the variable range and Doppler simulation. The development of a suitable acousto-optic component for this simulation application is described, as well as a description of a simulator employing this acousto-optic device. M.E.P.

A80-44517 # **Investigation of flight characteristics of the MRCA-Tornado in the framework of the official flight testing. II (Flugeigenschaftsuntersuchungen am MRCA-Tornado im Rahmen der amtlichen Flugerprobung. II).** R. Koehler and M. Marchand (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über das MRCA-Programm TORNADO, Neubiberg, West Germany, Dec. 13, 1979, Paper.* 18 p. In German.

Some aspects of flight characteristics determination as well as methods of determining characteristics values are discussed. It is shown that the Tornado is equipped with a flight controller that possesses its own complex dynamic behavior. The manner in which this influences the flight characteristics and the applicability of flight characteristic evaluation methods is investigated. The behavior of the control 'circuit' consisting of pilot, aircraft, and flight controller are analyzed by using results obtained by means of a system identification. M.E.P.

A80-44518 # **Investigations of the MRCA Tornado flight characteristics within official flight tests. I (Flugeigenschaftsuntersuchungen am MRCA Tornado im Rahmen der amtlichen Flugerprobung. I).** Mr. Buchacker. *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über das MRCA-Programm TORNADO, Neubiberg, West Germany, Dec. 13, 1979, Paper.* 23 p. In German.

The paper deals with tests aimed at identifying flight control system transfer functions and verify the specifications of the Tornado aircraft. The test procedures and methods of test data analysis are outlined. V.P.

A80-44520 **Structure and service life verification for the Tornado (Struktur und Lebensdauernachweis für Tornado).** Mr. Seibert and Mr. Arendts (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über das MRCA-Programm TORNADO, Neubiberg, West Germany, Dec. 13, 1979, Paper.* 35 p. In German.

The concept of the MRCA Tornado is reviewed, noting that the emphasis on low detectability and low cost has resulted in a 'F-16-size aircraft with F-111 capability'. The discussion of the aircraft's structure includes the configuration of the British and Italian portions as well as the German portion of the aircraft assembly. Finally, the results of the service life testing are presented. M.E.P.

A80-44630 **High-resolution intensified vidicon for low light level applications.** R. J. Malanoski (Westinghouse Electric Corp., Industrial and Government Tube Div., Horseheads, N.Y.). In: Recent advances in TV sensors and systems; Proceedings of the Seminar, San Diego, Calif., August 27, 28, 1979. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1979, p. 21-24.

A television camera tube developed for use in aircraft flight simulators is described. These simulators are used to provide training for low altitude flying using a model board to duplicate the terrain to be encountered. It is shown that the tube was designed to have high resolution and low geometric distortion while operating in an environment providing low irradiation. This was accomplished by coupling a high performance image intensifier to a high resolution 2-in. vidicon. In conclusion, it is noted that the tube is presently being used in simulators to train pilots for the Space Shuttle as well as for conventional fixed wing aircraft and helicopters. M.E.P.

A80-44774 **Investigation of some features of film cooling of fixed and moving blades.** S. M. Piotukh. *(Teploenergetika*, vol. 26, Nov. 1979, p. 37-41.) *Thermal Engineering*, vol. 26, Nov. 1979, p. 657-661. 5 refs. Translation.

The film cooling of fixed blades with a perforation on a leading edge and a segment consisting of four moving blades is studied. The fixed blade has three kinds of holes for air exit, and the moving blade has radial channels. Consideration is given to the efficiency of film cooling of blades over a section with convergent and divergent flows in a blade channel. V.T.

A80-44862 * **The effect of finite turbulence spatial scale on the amplification of turbulence by a contracting stream.** M. E. Goldstein (NASA, Lewis Research Center, Cleveland, Ohio) and P. A. Durbin (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics,* vol. 98, June 12, 1980, p. 473-508. 23 refs.

The turbulence downstream of a rapid contraction is calculated for the case when the turbulence scale can have the same magnitude as the mean-flow spatial scale. The approach used is based on the formulation of Goldstein (1978) for turbulence downstream of a contraction, with the added assumptions of a parallel mean flow at downstream infinity and turbulence calculated far enough downstream so that the nonuniformity of the mean flow field has decayed, and by treating the inverse contraction ratio as a small parameter. Consideration is given to the large-contraction-ratio and classical rapid-distortion theory limits, and to results at an arbitrary contraction ratio. It is shown that the amplification effect of the contraction is reduced when the spatial scale of the turbulence increases, with the upstream turbulence actually suppressed for a contraction ratio less than five and a turbulence spatial scale greater than three times the transverse dimensions of the downstream channel. A.L.W.

A80-44916 **Numerical methods of turbomachinery.** W. G. Habashi (Concordia University, Montreal, Canada). In: Recent advances in numerical methods in fluids. Volume 1.

Swansea, Pineridge Press, Ltd., 1980, p. 245-286. 100 refs.

Numerical methods currently utilized in the analysis of turbomachines are reviewed with emphasis on more recent developments in the field. New blade-to-blade calculations methods are generally based on finite difference or finite element discretizations. Three main approaches are examined with reference to hub-to-shroud calculations: (1) streamline curvature method, (2) matrix or finite difference methods, and (3) finite element methods. Consideration is also given to three-dimensional calculations that have found an application in turbomachinery passages. The methods are discussed in terms of accuracy, input data, solution times, and computer storage requirements. V.L.

A80-45035 # **Minimum fuel flight paths for given range.** J. V. Breakwell and H. Shoaee (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics and American Astronautical Society, Astrodynamics Conference, Danvers, Mass., Aug. 11-13, 1980, AIAA Paper 80-1660.* 6 p.

This paper examines the second variation in fuel expenditure in the neighborhood of a cruise at optimal constant speed and altitude, using range as independent variable. It is concluded that, at least for certain rather simple models for drag and fuel consumption per unit thrust, the total fuel expenditure can be reduced by certain periodic variations from steady cruise, if the period lies in a certain range. (Author)

A80-45036 # **A study of chattering cruise.** S. C. Houlihan, E. M. Cliff, and H. J. Kelley (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *American Institute of Aeronautics and Astronautics and American Astronautical Society, Astrodynamics Conference, Danvers, Mass., Aug. 11-13, 1980, AIAA Paper 80-1661.* 9 p. 13 refs.

It has been shown that steady-state cruise is not in general fuel-range optimal in studies by Speyer and others. The presently reported investigation makes use of a reduced-order ('energy') model for analysis of 'chattering' cruise, an idealization of time-shared operation between two Mach-number/altitude points, proceeding along the general lines of a study by Gilbert and Parsons. The characteristic nonconvexity of the hodograph figure, which leads to chattering, is examined and attempts are made to relate the extent of the effect to aerodynamic and propulsion-system parameters. Although substantial improvements in fuel economy appear in low-energy situations, the best improvement found in the cruise range is about 5%. (Author)

A80-45149 # **Influence of aircraft architecture on onboard systems (Influenza dell'architettura dei velivoli sugli impianti di bordo).** S. Chiesa. *Ingegneria,* May-June 1980, p. 129-133. In Italian.

The influence of aircraft architecture on onboard systems is examined; in particular, the usual disposition of the most important components is considered for various architectures of transport aircraft. Different connecting lengths are derived, along with direct and indirect effects on weight. Analytical expressions are obtained for various aspects of such weight increments. J.P.B.

A80-45150 # **Technology of graphite-resin composite materials and their applications in the aeronautical industry. II (Tecnologia dei materiali compositi grafite-resina e loro applicazioni nell'industria aeronautica).** G. Romeo. *Ingegneria,* May-June 1980, p. 134-143. 67 refs. In Italian.

The development of graphite-resin composite materials for use on aircraft is discussed, with emphasis placed on a spoiler and stabilizer for the Boeing 737, a DC-10 rudder and an L-1011 fin. Attention is given to their resistance to atmospheric agents, production and material costs, prepregs, and the construction sequence of the panels. J.P.B.

A80-45496 **The thermal impact of external pool fires on aircraft fuselages.** T. I. Eklund and C. P. Sarkos (FAA, Atlantic City, N.J.). *Journal of Fire and Flammability,* vol. 11, July 1980, p. 231-240. 5 refs.

A summary is presented of the results of recent NAFEC efforts as a representation of current knowledge of the interaction of external fuel fires with aircraft fuselages. Attention is given to results derived from three broad areas: (1) a C-133 fuselage exposed to fires up to 8 feet by 10 feet, (2) a DC-7 fuselage exposed to a 20-foot-square fuel fire, and (3) an array of model tests in which scaled fuselages were subjected to wide variety of fire conditions. M.E.P.

A80-45497 **767 - Boeing's next world-beater.** K. Regelin. *Interavia,* vol. 35, Aug. 1980, p. 678-686.

The design concepts and features of the Boeing 767 are described. The discussion covers Boeing's projected sales, the seven abreast seating, and the fuel efficient wing. Also covered are the use of new aluminum alloys, the flight control system including such functions as rudder, elevators, ailerons, spoilers, and tailplane trim. Finally, attention is given to the flight management system, the use of a two or three man crew, the fuel system and family growth plans. M.E.P.

A80-45498 **Europe's combat aircraft - Will it happen.** M. Lambert. *Interavia,* vol. 35, Aug. 1980, p. 702-704.

The problems of developing the European combat aircraft (ECA) are described. Attention is given to the various requirements each nation has, what type of aircraft it has to replace and what aircraft it is considering. Also covered are the tendency of France to follow its own national defense policies and the problems of financing the development of new aircraft designs. Finally, the option of buying American designs such as the F/A-18 is considered. M.E.P.

A80-45499 **Night/Adverse Weather A-10 at the crossroads.** R. Lopez. *Interavia,* vol. 35, Aug. 1980, p. 707-709.

The results of flight tests of the Night/Adverse Weather A-10 are surveyed. It is noted that the aircraft's manufacturer maintains that such an aircraft would offer significant advantages over the single seat version of the A-10 now in production and being deployed in Europe. It is shown that while the aircraft's merits are recognized, it is unclear if the aircraft will be procured by the USAF. Attention is

given to the controversy as to whether the basic A-10A should be transformed into a heavily automated single seater or modified into a two seater with pilot and weapons system officer. M.E.P.

A80-45500 **Mirage 2000 - A fighter tailored to a budget.** G. Chambost. *Interavia,* vol. 35, Aug. 1980, p. 712-714.

Problems in the development of the Mirage 2000 are surveyed, and it is reported that the aircraft will not be equipped with the Pulse Doppler Radar (RDI), as originally intended, when first delivered to the French Air Force in mid-1983. Instead the first production Mirage 2000s will employ the Multifunction Doppler Radar (RDM). Attention is given to development problems with the RDI system and an unfavorable comparison of the system to that of the F-16. In addition, it is reported that at least three versions of the Mirage 2000 will be used. Finally, the possible use of the Mirage 4000 is considered. M.E.P.

A80-45520 # **Evaluation of trainable gun with director fire control system.** N. M. Shah and J. Stalony-Dobrzanski (Northrop Corp., Aircraft Group, Hawthorne, Calif.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 38-44. Research supported by the Northrop Independent Research and Development Program. (AIAA 80-1718)

A trainable gun installation was designed for an advanced fighter aircraft. A simulator evaluation study was undertaken to evaluate hardware requirements and air combat performance improvement. The gun commands are generated by a director type fire control system (with simulated realistic radar noise). The trainable gun system and simulator mechanization are described. Results are presented which show a definite superiority of the trainable gun over a fixed gun. In addition to considerably shorter time-to-first-hit and higher confidence level, the pilot workload is greatly reduced. These performance improvements are obtained with relatively modest gun travel and servo power. (Author)

A80-45521 # **FAA Technical Center Digital Cockpit Simulation Facility navigation, guidance, and control software architecture.** E. F. Hitt, M. Kluse, B. L. Walters (Battelle Columbus Laboratories, Columbus, Ohio), and D. Eldredge (FAA Technical Center, Atlantic City, N.J.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 45-53. (AIAA 80-1719)

The paper describes the hardware and software architecture of the Digital Cockpit Simulation Facility which integrates additional subsystems which comply with the interface requirements, the MIL-STD-1553A protocol, and the software protocol discussed here. The design of the System Executive permits use of a master bus controller, with all other terminals responding as remote terminals; or the bus control function may be assigned to one terminal, and control subsequently passed to another terminal which was originally a remote terminal. The navigation, steering, and autopilot functions selected for the crew are functionally partitioned in the remote terminals which use a standard remote terminal executive; the modular structure allows a rapid change of crew input keyboard configurations, messages displayed to the crew, and the addition or deletion of navigation, guidance, and control modes. A.T.

A80-45522 # **An extended Kalman filter for the estimation of transfer alignment errors to an airborne vehicle.** J. G. Reid (USAF, Institute of Technology, Wright-Patterson AFB, Ohio), M. Tucker, and R. Dayan. In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 54-61. 7 refs. (AIAA 80-1720)

This paper develops and compares two techniques for the estimation of the transfer alignment error to an airborne vehicle through the combined use of tracking data (relative range and angle measurements, say from a radar) and a communications data link between the master inertial system and the airborne slave system. One technique is termed the 'Position Prediction Method' and the other is termed the 'Acceleration Prediction Method'. Both employ an extended Kalman filter to solve the inherently nonlinear estimation problems. The position prediction method is seen to be much simpler, while the acceleration prediction method is shown to offer significantly better accuracy and faster 'response'. This major performance improvement merits deeper investigation of the acceleration prediction method with probable comparable advantages to the estimation of other higher order error sources such as bias terms and drift. (Author)

A80-45523 * # **A model for helicopter guidance on spiral trajectories.** S. Mendenhall (General Electric Co., Cincinnati, Ohio) and G. L. Slater (Cincinnati, University, Cincinnati, Ohio). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 62-71. 6 refs. Grant No. NCA2-OR-130-801. (AIAA 80-1721)

A point mass model is developed for helicopter guidance on spiral trajectories. A fully coupled set of state equations is developed and perturbation equations suitable for 3-D and 4-D guidance are derived and shown to be amenable to conventional state variable feedback methods. Control variables are chosen to be the magnitude and orientation of the net rotor thrust. Using these variables reference controls for nonlevel accelerating trajectories are easily determined. The effects of constant wind are shown to require significant feedforward correction to some of the reference controls and to the time. Although not easily measured themselves, the controls variables chosen are shown to be easily related to the physical variables available in the cockpit. (Author)

A80-45545 * # **Development and flight evaluation of automatic flare laws with improved touchdown dispersion.** A. A. Lambregts (Boeing Commercial Airplane Co., Renton, Wash.) and J. F. Creedon (NASA, Langley Research Center, Hampton, Va.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 254-264. 14 refs. (AIAA 80-1757)

The paper describes the development and flight testing of automatic landing flare laws with improved longitudinal touchdown dispersion. The major sources of touchdown dispersion in current control laws and design objectives of this equipment are discussed. A ground-speed adaptive sink-rate control law and a specified flare trajectory control law were selected for development; the performance of resulting flare laws was evaluated by simulations and flight testing on the NASA TCV B-737 aircraft. These flare laws showed substantial improvement in longitudinal touchdown dispersion, when compared to a more conventional flare law used previously. A.T.

A80-45546 * # **Active flutter suppression using Linear Quadratic Gaussian theory.** J. K. Mahesh, C. R. Stone (Honeywell Systems and Research Center, Minneapolis, Minn.), W. L. Garrard (Minnesota, University, Minneapolis, Minn.), and H. J. Dunn (NASA, Langley Research Center, Hampton, Va.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 265-275. 20 refs. Contract No. NAS1-15486. (AIAA 80-1758)

This paper describes the application of Linear Quadratic Gaussian (LQG) methodology to the design of active control systems for suppression of aerodynamic flutter. A full-size wind tunnel model of a supercritical wing with associated sensors and actuators comprises the system to be controlled. Results of a synthesis methodology that provide small values of rms response, insensitivity to flight condition, and robust stability are presented. Results of control surface and sensor position optimization are also presented.

Both frequency response matching and residualization are used to obtain practical flutter controllers. (Author)

A80-45547 * # **Reliability/safety analysis of a fly-by-wire system.** L. D. Brock and H. A. Goddman (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 276-282. Contract No. NAS4-2571. (AIAA 80-1760)

An analysis technique has been developed to estimate the reliability of a very complex, safety-critical system by constructing a diagram of the reliability equations for the total system. This diagram has many of the characteristics of a fault-tree or success-path diagram, but is much easier to construct for complex redundant systems. The diagram provides insight into system failure characteristics and identifies the most likely failure modes. A computer program aids in the construction of the diagram and the computation of reliability. Analysis of the NASA F-8 Digital Fly-by-Wire Flight Control System is used to illustrate the technique. (Author)

A80-45548 * # **Backup flight control system for a highly maneuverable remotely piloted research vehicle.** C. E. Hoyt (Teledyne Ryan Aeronautical, San Diego, Calif.), R. W. Kempel, and R. R. Larson (NASA, Washington, D.C.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 283-289. 5 refs. (AIAA 80-1761)

NASA is currently conducting flight tests of a remotely piloted subscale advanced fighter configuration as part of the Highly Maneuverable Aircraft Technology (HiMAT) program. This paper describes the initial development, user modification, and flight test experience of a back-up control system (BCS) contained within one of two onboard microprocessors. The development of the BCS proceeded in two distinct steps: the initial contractor development of control laws and logic to satisfy BCS design objectives, and user modifications required to satisfy operational requirements. A brief resume of flight qualification procedures and pilot comments is presented. (Author)

A80-45555 # **Periodic optimal cruise of a hypersonic vehicle.** J. L. Speyer, D. Dannemiller, and D. Walker (Texas, University, Austin, Tex.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 338-346. 9 refs. NSF Grant No. ECS-79-18246. (AIAA 80-1777)

Closed periodic orbits for a hypersonic vehicle over a spherical earth are determined which result in improved average fuel usage per range. The model is simplified such that the steady state cost is a function of only dynamic pressure and improved periodic performance is due only to a kinetic-potential energy interchange. Families of periodic extremal orbits are followed in the direction of decreasing cost. A second order sufficient condition for nonoptimality, i.e., distinct eigenvalues of the Monodromy matrix lie on the unit circle, is monitored. To date, the best nonminimizing periodic orbit obtained an 11% cost improvement over steady state. (Author)

A80-45556 * # **A new approach to active control of rotorcraft vibration.** N. K. Gupta (Integrated Systems, Inc., Stanford, Calif.), R. W. Du Val (NASA, Ames Research Center, Moffett Field, Calif.), and J. Fuller (Systems Control, Inc., Palo Alto, Calif.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 347-358. 13 refs. (AIAA 80-1778)

A state-variable feedback approach is utilized for active control of rotorcraft vibration. Fuselage accelerations are passed through undamped second-order filters with resonant frequencies at N/rev. The resulting outputs contain predominantly the N/rev vibration components, phase shifted by 180 deg, and are used to drive the blade pitch to cancel this component of fuselage vibration. The linear-quadratic-gaussian (LQG) method is used to design a feedback control system utilizing these filtered accelerations. The design is based on a nine-degree-of-freedom linear model of the Rotor System Research Aircraft (RSRA) in hover and is evaluated on a nonlinear blade-element simulation of the RSRA for this flight condition. The system is shown to essentially eliminate vibrations at N/rev in all axes. The required blade-pitch amplitude is within the capability of conventional actuators at the N/rev frequency. (Author)

A80-45666 # **Application of viscous analyses to the design of jet exhaust powered lift installations.** E. Tjonneland and S. F. Birch (Boeing Military Airplane Development, Seattle, Wash.). *(American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-15.) ASME, Transactions, Journal of Engineering for Power,* vol. 102, July 1980, p. 626-631. 39 refs.

The application of available numerical methods to the design of powered lift installations is reviewed. For this application, where strong coupling exists between the jet exhaust and the external flow, a three-dimensional viscous analysis tool is needed. The task of selecting a suitable analysis procedure is first outlined, with particular emphasis on the need for careful coordination of the various elements of the task. Problems and progress in the development of turbulence models are then discussed, and some selected three-dimensional calculations are presented to illustrate recent progress. Finally, a numerical procedure, currently under development for a particular powered lift application, is briefly described. (Author)

A80-45667 # **Status of centrifugal impeller internal aerodynamics. I - Inviscid flow prediction methods. II - Experiments and influence of viscosity.** D. Adler (Technion - Israel Institute of Technology, Haifa, Israel). *ASME, Transactions, Journal of Engineering for Power,* vol. 102, July 1980, p. 728-746. 136 refs. Navy-sponsored research.

The paper reviews the recent developments and the present state-of-the-art of centrifugal compressor internal aerodynamics. Emphasis is placed on inviscid centrifugal impeller flow. Topics included in the review are: two-dimensional subsonic and transonic inviscid flows as well as three-dimensional inviscid flows. V.T.

A80-45694 # **The relationship between reliability and airworthiness (Prispevek k vymezeni souvislosti spolehlivosti a zpusobilosti).** J. Schindler. *Zpravodaj VZLU,* no. 1, 1980, p. 5-21. 18 refs. In Czech.

The concepts of reliability and airworthiness in the field of civil aviation are discussed. Attention is given to questions of acceptable risk and to the determination of failure probabilities. The relative suitability of quantitative and qualitative approaches of risk estimation is examined. B.J.

A80-45695 # **Concerning the design of spherical bearings (Prispevek k problematice navrhu kloubovych lozisek).** K. Tyzner. *Zpravodaj VZLU,* no. 1, 1980, p. 23-28. 5 refs. In Czech.

A method for the simplified calculation of the life and carrying capacity of spherical beings (for use in aircraft design) is presented. The effects of various factors on the design as a function of the working surface of the bearing are described. B.J.

A80-45697 # **The objective necessity of the fail-safe design philosophy (Objektivni nutnost konstrukcni strategie fail-safe).** V. Nejedly. *Zpravodaj VZLU,* no. 2, 1980, p. 59-69. 17 refs. In Czech.

Safety and fatigue criteria for civil transport aircraft are reviewed, and it is argued that the safe-life design philosophy can satisfy neither the safety requirements nor the fatigue life requirements of future transport aircraft. Instead it is recommended that the fail-safe design philosophy be implemented, particularly for light transport aircraft. B.J.

A80-45701 # **The aerodynamic characteristics of oscillating airfoils (Charakterystyki aerodynamiczne profili oscylujacych).** J. Kacprzyk, *Instytut Lotnictwa, Prace,* no. 79, 1979, p. 3-14. 8 refs. In Polish.

The differences between the static and dynamic characteristics in plane flow of helicopter airfoils are considered. The results of wind tunnel tests performed on the Vertol V23010 and NACA 23012 airfoil sections are used to show the effect of the Mach number and the oscillation frequency on the aerodynamic characteristics of the airfoil. B.J.

A80-45702 # **The dynamics of helicopter flight in limiting conditions (Dynamika granicznych przebiegow lotu smiglowca).** K. Szumanski. *Instytut Lotnictwa, Prace,* no. 79, 1979, p. 15-60. 19 refs. In Polish.

An attempt is made to solve the control problem for an arbitrary flight process under limiting conditions, i.e., when the state vector varies in the neighborhood of the limiting values. A general method of solution is developed and applied to problems of the flight dynamics of a helicopter under limiting conditions. The determination of the limiting conditions for initial emergency maneuvers in the case of the failure of the engine or of the driving gear is considered as an example. B.J.

A80-45704 # **Spline curves and their application to the design of turbomachine blade profiles (Krzywe typu spline i ich zastosowanie do profilowania przekrojow lopatek maszyn wirnikowych).** K. Kawalec and A. Lichota. *Instytut Lotnictwa, Prace,* no. 79, 1979, p. 75-86. In Polish.

A theoretical introduction to problems of obtaining spline curves is presented; the approach presented is based on the use of third-order polynomials. The application of this approach to the design of turbomachine blade profiles is discussed. B.J.

A80-45705 # **Dynamic tests of a test bed for piston engines (Badania dynamiczne stanowiska hamowni silnikow tlokowych).** M. Jez and M. Dziawgo. *Instytut Lotnictwa, Prace,* no. 79, 1979, p. 87-103. In Polish.

Theoretical and experimental studies were performed on a piston-engine test bed. Two theoretical methods were developed: (1) one for computing the dynamic loads of an opposed-cylinder engine with independent crank mechanisms and (2) one for determining the natural torsional vibrations of the system. Tests of two corrected versions of the transmission were performed. The operation of the rotating system of the test bed was improved by the replacement of one of the couplings and by the modification of the location and the inertia of the flywheel. B.J.

A80-45706 # **SP-type flow stabilizers (Sygnalizatory przeplywu typu SP).** J. Seroka. *Instytut Lotnictwa, Prace,* no. 80, 1980, p. 3-14. In Polish.

The paper describes special type flow stabilizers which signal flow intensity with a simpler operation and simplicity of structure than conventional flowmeters. The principle of their operation is based on the use of hydraulic resistance due to a piston moving in a cylindrical housing; for a specific value of that resistance, the piston moves against the tension of a spring. A permanent magnet incorporated in the piston brings the contacts of a reed relay together, thus switching on the signalling lamp. An additional increase in flow intensity opens a valve incorporated in the piston, thus reducing the hydraulic drag. A.T.

A80-45709 # **Geometrical design of double-circular arc blades (Projektowanie geometrii lopatek o profilu dwulukowym).** K. Kawalec and A. Lichota. *Instytut Lotnictwa, Prace,* no. 80, 1980, p. 67-81. In Polish.

The paper presents a geometrical design procedure for double circular arc airfoils. The airfoil geometry is defined by data resulting from compressor gas-dynamic calculations and design and production requirements. The airfoil geometry equations are derived and a computer program is suggested. An additional improvement of the airfoil design procedure can be achieved by an additional computer program for automatic drafting. A.T.

A80-45718 **Dynamics of flying equipment elements made from composite materials.** A. S. Vol'mir and E. V. Dedik. *(Mekhanika Kompozitnykh Materialov,* vol. 15, Nov.-Dec. 1979, p. 1042-1047.) *Mechanics of Composite Materials,* vol. 15, no. 6, May 1980, p. 720-724. 6 refs. Translation.

The paper is concerned with the dynamic characteristics of composite wings of complex configurations modeled by an orthotropic plate of variable stiffness. The finite difference method is used in a special form to accomodate various boundary conditions. The problem of the frequencies and forms of inherent vibrations is solved using a computer. The effects of the wing length and of the distribution of mass and stiffness are examined. The convergence of the method is checked on a model problem involving a triangular isotropic plate of constant thickness. It is shown that for practical calculations it is sufficient to have a grid with 30-40 calculation nodes. V.L.

A80-45734 * # **Some effects of cruise speed and engine matching of supersonic inlet design.** L. H. Bangert, D. M. Santman, G. Horie, and L. D. Miller (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1807.* 9 p. 9 refs. Contract No. NAS1-14625.

An analytical study was conducted to determine the impact of flight Mach number on inlet type selection for a supersonic cruise aircraft. External and mixed-compression axisymmetric and two-dimensional inlets were considered. The internal contraction of the mixed-compression inlets was limited to achieve self-starting. At Mach 2.0, the axisymmetric mixed-compression inlet provided the best aircraft range. At Mach 2.3, the two-dimensional mixed-compression inlet was the most attractive if enough variable geometry were incorporated to minimize spillage during subsonic cruise. Increases in takeoff-to-cruise air flow ratio gave lower aircraft range. (Author)

A80-45735 * # **Top inlet system feasibility for transonic-supersonic fighter aircraft applications.** T. L. Williams and B. L. Hunt (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1809.* 15 p. 5 refs. Contract No. NAS2-10584.

Top inlet flow field and inlet performance data are presented which provide preliminary insight into the feasibility of upper-fuselage mounted inlet systems for transonic-supersonic fighter aircraft. Presented data span the Mach 0.2 to 2.0 envelope and enable evaluation of the influence of key aircraft configuration variables - inlet location, wing position, wing leading-edge extension (LEX) planform area, and variable incidence canards - on top inlet performance. The viability of this concept relative to more conventional inlet/airframe integrations is assessed via comparative evaluation of top and conventional inlet flow field parameters at transonic and supersonic speeds. It is shown that the action of the wing LEX vortex system produces a significant improvement in top inlet performance. Currently available transonic-supersonic data indicate that top inlet systems pose a viable configuration option for fighter aircraft requiring moderate angle of attack capability. However, recently acquired data indicate that increased angle of attack capability may be obtained by increasing wing leading-edge sweep angle. (Author)

A80-45738 # **Product performance enhancement in the United States Air Force.** J. A. Stempson (USAF, Systems Command, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1816.* 5 p.

Maintenance and support of Air Force systems and equipment has been traditionally reserved to the military. Consequently, manufacturers and suppliers of military hardware are frequently not deeply involved in or oriented toward continuing field support of their product. Since military systems and equipment tend to embody new technology and state-of-the-art advances, it is often difficult for the military alone to ensure proper product performance, particularly during the early stages of field use. This paper discusses the need for product performance enhancement from the view of current Air Force and contractor experience and responsibilities. Implementation techniques and their associated risks and benefits are discussed and proposed. (Author)

A80-45739 # **An assessment of Sea Based Air Master Study.** C. E. Chambers (U.S. Navy, Center for Naval Analyses, Arlington, Va.), R. G. Perkins, Jr. (U.S. Navy, Naval Air Systems Command, Washington, D.C.), and J. T. Tyler (U.S. Navy, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1820.* 13 p.

The Sea Based Air Master Study provided a systematic investigation of alternatives to determine the most capable and cost effective sea based air force structure for the 1990s and beyond. Studies included various ship platforms, aircraft designs and associated supporting systems. Aircraft mission performance capabilities were generally equal across the different classes (CTOL, STOL, STOVL and V/STOL) of aircraft investigated. Good agreement between projected government and industry designs was shown. Results were used to compare effectiveness of alternative forces on an equal cost basis. Findings developed showed increased aircraft weight, size and cost with increased basing flexibility. Aircraft acquisition costs were the largest component of sea based air force costs. In the equal cost force comparisons, there was no clear preference between CTOL and V/STOL aircraft. (Author)

A80-45740 # **A tilt rotor design that provides economical extended range VTOL transportation to offshore oil platforms.** R. K. Wernicke (Bell Helicopter Textron, Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1822.* 7 p.

A commercial tilt rotor design for passenger transportation to offshore oil platforms is described. It is shown that a tilt rotor can double the range of transport rotorcraft, covering twice the distance for the same enroute time. Additionally, the fuel consumed per passenger mile is significantly less than for helicopters. V.T.

A80-45741 # **Acquisition logistics management in naval aviation.** J. F. Sylvester (U.S. Navy, Naval Air Systems Command, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1827.* 20 p.

Acquisition logistics management in naval aviation is discussed with particular emphasis placed on maintenance capability and material support. Planning for support is separable into two categories: planning that must be done prior to the signing of a full scale development (FSD) contract and planning that occurs following the development contract award. To achieve the pre-FSD goals, it is necessary to address three key critical elements: design features, contract requirements, and budget requirements. Once source selection is completed, the development contract signed, and the budget in place, an ILS development program begins. V.T.

A80-45742 # **Affordable automatic testing - A modular concept.** R. O. Byrne and M. K. Allen (USAF, Acquisition Logistics Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1828.* 6 p.

In this paper we will present some of the problems related to the development and acquisition of automatic test equipment (ATE) and provide rationale on how an Air Force modular concept results in affordable weapon system support. We will address the effects that a modular approach will have upon those who will develop, acquire, use, and support Air Force ATE in the future. (Author)

A80-45743 # **Design synthesis of an advanced technology agricultural aircraft for the 1979 AIAA/Bendix design competition.** J. W. Humphreys (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1848.* 6 p.

A decision-making process from which an agricultural aircraft design was realized is described. The project was initiated in response to a request for proposal (RFP) issued for the 1979 AIAA/Bendix design competition. The research, analysis, evaluation, and design aspects of the project are presented along with the synthesis of the final report. V.T.

A80-45744 # **The effects of turbine inlet temperature and engine complexity on VCE/RALS powered supersonic V/STOL aircraft.** W. S. Willis (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1853.* 5 p.

General Electric's Variable-Cycle Engine (VCE) has been shown to be a promising concept for optimally matching the engine cycle to changing flight requirements. This engine, when configured as a Remote Augmentor Lift System (RALS), results in an attractive propulsion system for a high performance supersonic V/STOL fighter. A study was conducted under Navy sponsorship to evaluate the impact of reducing turbine inlet temperature (T4) and engine complexity on the aircraft take-off gross weight and life cycle costs for a Deck Launched Interceptor supersonic mission. The study showed that reductions in T4 levels and the resultant reductions in engine thrust/weight had an adverse affect on aircraft size. Removal of the variable-cycle features of the engine did not significantly affect aircraft size, however, it would affect performance in the alternate subsonic missions. (Author)

A80-45745 # **Contingency rating options for ASW-AEW V/STOL aircraft.** V. Crafa (Grumman Aerospace Corp., Bethpage, N.Y.) and V. Reed (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1854.* 10 p. Contract No. N00019-79-C-0154.

A study was conducted to determine the effect of contingency rating options on AEW/ASW V/STOL aircraft sizing. The baseline aircraft selected for the study was the Grumman Design 698 with two advanced technology turbofan engines, and sized for an emergency vertical landing with one engine inoperative (EVL). Alternate engine ratings were investigated to reduce the penalty associated with the baseline EVL requirement. Study results showed that the EVL requirement imposes a 9% TOGW penalty which can be eliminated by using contingency ratings. (Author)

A80-45746 # **The effect of cross-shafting on engine-out vertical landing reliability of V/STOL aircraft.** W. S. Willis (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1858.* 5 p.

The probability of completing successful vertical landings of a VSTOL aircraft with and without cross-shafting is studied, considering realistic reliability levels of components. Study results show that the benefit of cross-shafting in an operational aircraft is less than expected and dependent upon an extensive development program. V.T.

A80-45747 # **The Lear Fan - A significant step toward fuel efficient airplanes.** R. R. Tracy (Lear Fan Corp., Reno, Nev.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1860.* 8 p. 12 refs.

The Lear Fan 2100 Executive Airplane is described. The aircraft is a low-wing monoplane with a single rotation pusher propeller located aft of the Y-form empennage. The performance and technology of the aircraft are discussed, including numerical computational analysis, aerodynamic technology and simulation, advanced composite structural materials, and derivative state-of-the-art system design. V.T.

A80-45748 * # **Single pilot IFR autopilot complexity/benefit tradeoff study.** H. P. Bergeron (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1869.* 8 p. 5 refs.

Five levels of autopilot complexity were flown in a single engine IFR simulation for several different IFR terminal operations. A comparison was made of the five levels of complexity ranging from no-autopilot to a fully coupled lateral and vertical guidance mode to determine the relative benefits vs. complexity/cost of state-of-the-art autopilot capability in the IFR terminal area. For the levels of progression tested, the heading select mode made the largest difference in decreasing workload and simplifying the approach task. It was also found that the largest number of blunders was detected with the most fully automated mode. The data also showed that, regardless of the autopilot mode, performance during an IFR approach was highly dependent on the type of approach being flown. These results indicate that some level of automation is desirable when making IFR approaches in a high workload environment, but also that some disturbing trends are associated with the higher levels of automation. (Author)

A80-45749 # **Vectored engine over wing concept for V/STOL supersonic fighter.** W. H. Foley and R. W. Woodrey (General Dynamics Corp., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1877.* 6 p. 5 refs. Contract No. N0019-79-C-0156.

A vectored-engine-over-wing (VEO-Wing) concept for V/STOL flighter aircraft is discussed. Consideration is given to aircraft configurations and technology utilization. An aircraft in the 45,000 LB TOGW class was designed, analyzed, and compared to equivalent CTOL, STOVL, and STOL aircraft. V.T.

A80-45750 # **Forward swept wing flight demonstrator.** N. J. Krone, Jr. (Defense Advanced Research Projects Agency, Arlington, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1882.* 9 p. 5 refs.

Advanced composite materials are analyzed as a solution to the forward swept wing (FSW) divergence problem. Consideration is given to aeroelastic divergence studies that verified the ability to design high performance aircraft without weight penalty. Manned and unmanned FSW flight demonstrators are discussed, along with initial and follow-on technology demonstrations. V.T.

A80-45751 # **The Forward Swept Wing - A unique design challenge.** G. Spacht (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1885.* 4 p.

A Forward Swept Wing Technology Demonstrator aircraft has been designed incorporating advanced composites, variable camber, relaxed static stability, close coupled canard, and a thin supercritical wing. The integration of these technologies into the configuration are discussed, with special emphasis placed on selecting the optimal level of instability, as well as designing the wing/canard lifting surfaces. (Author)

A80-45824 # **The Rolls-Royce Gem.** C. Buck (Rolls-Royce, Ltd., Aero Div., Leavesden, Herts., England). *Aircraft Engineering,* vol. 52, Aug. 1980, p. 18-22.

The extensive development work which has brought the Rolls-Royce Gem free-turbine turboshaft engine to its current status is reviewed, and the achievements which have been accomplished are assessed. Future development programs required to match the engine to the needs of the helicopter industry are examined. V.P.

A80-45840 **On the unsteady, wake induced lift on a slotted airfoil.** M. S. Howe (Bolt Beranek and Newman, Inc., Cambridge, Mass.). *Journal of Sound and Vibration,* vol. 71, July 22, 1980, p. 161-170. 10 refs.

A theoretical model is examined to determine the influence of a slot in a thin airfoil on the unsteady lift caused by vortices shed into the wake. It is shown that at sufficiently low reduced frequencies based on the width of the slot, vorticity production at the edges of the slot can prevent penetration by the unsteady flow so that the airfoil behaves as if the slot were absent. There exists a range of frequencies, however, in which the magnitudes of both the lift and the accompanying radiated sound can be significantly reduced relative to their respective levels for the unslotted airfoil. (Author)

A80-45841 * **Aerodynamic analysis of a supersonic cascade vibrating in a complex mode.** J. E. Caruthers (Tennessee, University, Space Institute, Tullahoma, Tenn.) and R. E. Riffel (General Motors Corp., Detroit Allison Div., Indianapolis, Ind.). *Journal of Sound and Vibration,* vol. 71, July 22, 1980, p. 171-183. 10 refs. Contract No. NAS3-20055.

An analysis is presented which has been used to predict the unsteady aerodynamic behavior of a finite supersonic cascade of airfoils forced in harmonic oscillation with airfoil-to-airfoil variations in amplitude. Theoretical predictions are compared with some recent experimental results at a reduced frequency representative of actual fan or compressor flutter cases. The similarity of the experimental situation in the finite cascade to the flutter of a severely mistuned rotor is noted. (Author)

A80-45845 **Effect of background levels on community responses to aircraft noise.** S. M. Taylor, F. L. Hall, and S. E. Birnie (McMaster University, Hamilton, Ontario, Canada). *Journal of Sound and Vibration,* vol. 71, July 22, 1980, p. 261-270. 13 refs.

The effect of variations in background noise levels on community reactions to aircraft noise has been investigated by using questionnaire and sound level data collected at a stratified random sample of residential sites in the vicinity of Toronto International Airport. The effects of variations in background noise on both individual and aggregate responses to aircraft noise have been examined. The response variables considered include annoyance, activity interference and complaints. The results of various statistical analyses show that the effect of background level is generally not significant. These findings are consistent with relevant findings from previous laboratory studies, but not with those from previous field studies. (Author)

A80-45855 **Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.** Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. 682 p. Members, $30.; nonmembers, $40.

The Conference published papers on vortex shedding from noncircular bodies in supersonic flow, data analysis to identify coherent flow structures, spin prediction techniques, pilot-aircraft system response to wind shear, a model-based technique for predicting pilot opinion ratings for large commercial transports, mathematical modeling of the aerodynamics of high-angle-of-attack maneuvers, a drag and stability analysis of hypersonic spin stabilized projectiles, subsonic stability and control flight test results of the Space Shuttle, Space Shuttle stability and control flight test techniques, and ground plane effects on flow over a contoured surface determined by photon correlations. A.T.

A80-45861 * # **A study of stall deterrent systems for general aviation aircraft.** A. G. Bennett, J. K. Owens, and G. Bull (Mississippi State University, Mississippi State, Miss.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collec-

tion of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 51-61. 7 refs. Grant No. NsG-1249. (AIAA 80-1562)

Stall deterrent concepts for general aviation aircraft have been investigated using simulation studies and flight test experiments. It was found that the simulator was suitable for the development of deterrent system concepts, but the simulator was unacceptable for pilot evaluation of system effectiveness under typical stall/spin accident conditions. A Cessna 319 was outfitted with sensors, servoactuators, and analog control logic necessary to investigate a wide range of stall deterrent systems. It was found that an acoustic stall sensor and an error control law were sufficient for stall deterrence. The pitch intervention control system prevented aircraft stall for all aircraft configurations and pilot inputs. The variable up elevator stop concept was found to be effective for slow decelerations to aircraft stall. The stall deterrent systems were evaluated by four professional pilots and three low time pilots. (Author)

A80-45862 * # Stall/spin flight results for the remotely piloted spin research vehicle. K. W. Iliff (NASA, Flight Research Center, Edwards, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 62-75. 9 refs. (AIAA 80-1563)

The unmanned, remotely piloted, unpowered, spin research vehicle was used to evaluate the effects of the nose boom and of a wind tunnel-designed nose strake on the vehicle's stall/spin characteristics. The flight-determined directional stability derivatives and the attempted spin entries indicated that the vehicle with a nose strake had increased resistance to departure and spin. The acquisition of high quality steady spin data for this vehicle was made possible by the remotely piloted technique. The zero control smooth spin modes were found to be highly repeatable for a given configuration and to vary with forebody configuration. Several spin recovery techniques, including a nose parachute, are also evaluated. (Author)

A80-45863 * # Spin prediction techniques. W. Bihrle, Jr. and B. Barnhart (Bihrle Applied Research, Inc., Jericho, N.Y.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 76-82. 15 refs. Contract No. NAS1-14849. (AIAA 80-1564)

The NASA Langley Research Center has the responsibility to advance the state-of-the-art in the area of stall/spin technology. This includes the development and validation of experimental and analytical techniques for the prediction of stall/spin characteristics. As a part of this effort, a rotary balance facility located in the Langley spin tunnel was developed two and a half years ago to rapidly identify an airplane's aerodynamic characteristics in a rotational flow environment. On-line rotary balance data plots and on-line predicted steady spin modes permit the designer to develop, on site, a configuration highly resistant to spins, or one which has good spin characteristics, i.e., no spin equilibrium conditions possible with lateral-directional controls neutral, if the airplane is to be used for acrobatic maneuvers or training. The rotary balance data are also used to compute time histories of a spin's incipient, developed, and recovery phases. These spin analysis techniques and their correlation with spin tunnel model and full-scale flight results are discussed herein. (Author)

A80-45864 * # A dynamic analysis of the motion of a low-wing general aviation aircraft about its calculated equilibrium flat spin mode. M. B. Tischler (Systems Technology, Inc., Hawthorne, Calif.) and J. B. Barlow (Maryland, University, College Park, Md.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 83-95. 26 refs. Grant No. NsG-1570. (AIAA 80-1565)

The properties of the flat spin mode of a general aviation configuration have been studied through analysis of rotary balance data, numerical simulation, and analytical study of the equilibrium state. The equilibrium state is predicted well from rotary balance data. The variations of yawing moment and pitching moment as functions of sideslip have been shown to be of great importance in obtaining accurate modeling. These dependencies are not presently available with sufficient accuracy from previous tests or theories. The stability of the flat spin mode has been examined extensively using numerical linearization, classical perturbation methods, and reduced order modeling. The stability exhibited by the time histories and the eigenvalue analyses is shown to be strongly dependent on certain static cross derivatives and more so on the dynamic derivatives. Explicit stability criteria are obtained from the reduced order models. (Author)

A80-45865 # Departure and uncoordinated roll reversal boundaries for fighter configurations. W. Bihrle Jr. and B. Barnhart (Bihrle Applied Research, Inc., Jericho, N.Y.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 96-103. 6 refs. Contracts No. N62269-TF7-0179; No. F33615-78-C-3600. (AIAA 80-1566)

Studies are reported which generated design charts and developed associated boundaries for identifying departure and uncoordinated roll-reversal flight characteristics as a function of aerodynamic rolling and yawing moment coefficients typical of fighter airplanes for various pitching moment characteristics. This information should be valuable for specification, design and evaluation purposes. The investigation utilized a large angle, six-degree-of-freedom digital computer program to simulate the motions of a fighter performing a severe air combat maneuver. The developed uncoordinated roll reversal boundaries may be applied to any fighter configuration whereas the developed departure boundaries are applicable only to fighter configurations exhibiting static pitch stability. Unaugmented airframes having pitch instability impose more stringent requirements on the rolling and yawing moment coefficients to avoid departure susceptibility. However, a simple angle-of-attack feedback augmentation system can markedly improve the departure resistance of both stable and unstable airframes given sufficient control authority. (Author)

A80-45866 # Stability of asymmetric equilibrium flight states. J. E. Cochran, C.-S. Ho, and G. A. Castleberry (Auburn University, Auburn, Ala.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 104-115. 10 refs. Research supported by Auburn University. (AIAA 80-1567)

The stability of asymmetric equilibrium flight states - characterized by nonzero equilibrium sideslip angles and/or velocity roll angles and, generally, nonzero lateral/directional control surface deflections - is studied. Linear equations of motion, valid in the neighborhood of an arbitrary asymmetric equilibrium flight state, are presented which contain terms that result in coupled longitudinal and lateral modes, rather than classical uncoupled modes, when the trim state is asymmetric. Reduced-order linear equations, based on the assumption of constant flight velocity are also presented. These represent generalizations of Kalviste's coupled equations, since they include the effects of damping. The full-order and the reduced-order linear equations are used to calculate stability characteristics of asymmetric equilibrium flight states of a typical multi-engine jet transport which exist after failure of an outboard engine during climbout. (Author)

A80-45867 # A non-Gaussian atmospheric turbulence model for flight simulator studies of aircraft handling qualities. C. J. Jansen (Nationaal Lucht- em Ruimtevaartlaboratorium, Amsterdam, Netherlands). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 116-123. 6 refs. (AIAA 80-1568)

The present turbulence model is the result of a continuing effort in improving the realism of the NLR flight simulator. The turbulence

simulation has evolved from a simple 3-components Gaussian model to a complex 5-components model. It has the following characteristics of naturally-occuring turbulence: intermittency, patchiness, influences of altitude and windspeed on scale length and intensity, 'above/below clouds' effect. Handling qualities ratings and pilot-aircraft performance were evaluated for a range of turbulence settings concerning intermittency and patchiness. Based on the results of the present simulation study a turbulence model with realistic characteristics including combined effects of intermittency and patchiness is recommended for application in handling quality simulation investigations. (Author)

A80-45868 * # **Pilot-aircraft system response to wind shear.** B. S. Turkel (FWG Associates, Inc., Tullahoma, Tenn.), W. Frost (EWG Associates, Inc.; Tennessee, University, Tullahoma, Tenn.), and D. W. Camp (NASA, Marshall Space Flight Center, Atmospheric Sciences Div., Huntsville, Ala.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 124-132. 5 refs. Contract No. NAS8-33458. (AIAA 80-1569)

The nonlinear aircraft motion and automatic control computer model of Frost and Reddy has been expanded to incorporate the human pilot into simulations of aircraft response to wind shear. Fixed-stick, autopilot, and manned computer simulations are made with an aircraft having characteristics of a Queen Air (small commuter-type aircraft) flown through longitudinal winds measured by a Doppler radar beamed along the glide slope during the SESAME '79 experiments in Oklahoma. Simulations are also made flying a model Boeing 727 through sinusoidal head wind to tail wind shears at the phugoid frequency to evaluate the response of manned aircraft in thunderstorm wind environments. (Author)

A80-45869 * # **Impact of longitudinal flying qualities upon the design of a transport with active controls.** S. M. Sliwa (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 133-141. 12 refs. (AIAA 80-1570)

Direct constrained parameter optimization was used to optimally size a medium range transport for minimum direct operating cost. Several stability and control constraints were varied to study the sensitivity of the configuration to specifying the unaugmented flying qualities of transports designed with relaxed static stability. Additionally, a number of handling quality related design constants were studied with respect to their impact to the design. (Author)

A80-45870 * # **Experience with an adaptive stick-gain algorithm to reduce pilot-induced-oscillation tendencies.** B. G. Powers (NASA, Flight Research Center, Edwards, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 142-154. (AIAA 80-1571)

As part of a program to improve the approach and landing characteristics of the Space Shuttle, the NASA Dryden Flight Research Center has developed an adaptive algorithm that varies the longitudinal stick gearing to reduce the Shuttle's tendency for pilot-induced oscillation (PIO). This paper describes the algorithm, which is known as the PIO suppressor, and discusses some of the tradeoffs involved in optimizing the system. The results of fixed-base, moving-base, and in-flight simulations of the PIO suppressor are presented. (Author)

A80-45871 # **Application of existing roll response criteria to transport aircraft with advanced flight control systems.** M. F. C. van Gool (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 155-165. 20 refs. Research supported by the Netherlands Agency for Aerospace Programs. (AIAA 80-1572)

Two experimental flight simulator programs have been carried out in which a number of characteristics of a roll-rate-bank-angle-hold system have been investigated for transport aircraft in the approach and landing flight phase. The results indicate that the existing roll response criteria are in many cases too lenient. This surprising observation suggests that advanced flight control systems must comply with stricter criteria than conventional systems to obtain the same degree of pilot approval. It is concluded that a pilot, having available a more precise flight control system, increases the internal 'standard' according to which he judges handling qualities. Based on these results existing criteria are redefined and new criteria formats are reported. (Author)

A80-45872 * # **A model-based technique for predicting pilot opinion ratings for large commercial transports.** W. H. Levison (Bolt Beranek and Newman, Inc., Cambridge, Mass.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, *Collection of Technical Papers.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 166-174. 15 refs. Contract No. NAS1-15529. (AIAA 80-1573)

A model-based technique for predicting pilot opinion ratings is described. Features of this procedure, which is based on the optimal-control model for pilot/vehicle systems, include (1) capability to treat 'unconventional' aircraft dynamics, (2) a relatively free-form pilot model, (3) a simple scalar metric for attentional workload, and (4) a straightforward manner of proceeding from descriptions of the flight task environment and requirements to a prediction of pilot opinion rating. The method is able to provide a good match to a set of pilot opinion ratings obtained in a manned simulation study of large commercial aircraft in landing approach. (Author)

A80-45874 # **Spin profile tailoring for the improved 2.75-inch rocket.** D. M. Bergbauer, J. H. Ferguson (U.S. Navy, Naval Ordnance Station, Indian Head, Md.), R. W. Bergman (U.S. Army, Missile Command, Redstone Arsenal, Ala.), and R. Bentley (VEDA, Inc., Arlington, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 182-186. (AIAA 80-1575)

An improved 2.75-inch rocket with wrap-around folding fins was developed for firing from both high speed and low speed aircraft. By fluting the exit cone of the nozzle, the flow of rocket motor exhaust gases generates torque which imparts spin to the rocket during its nominal 1-second burn time. Because the rocket is spinning as it exits its tubular launcher, the adverse effects of thrust malalignment are reduced. Included are the effects of spin on fuse arming and warhead functioning as well as increased drag effects and instability from roll-pitch coupling. The approach used in tailoring the spin profile primarily involved changes to the leading and trailing edges of the fins to modify roll moments as a function of Mach number. The results for a nominal 20-second flight show a typical spin profile: +10 r/s at launcher separation, reaching +45 r/s at motor burnout, rapid spin decay with spin reversal at about three seconds, and oppositely spinning up to approximately -15 r/s and maintaining this level throughout the remainder of the subsonic flight segment. (Author)

A80-45878 * # **The linear and non-linear aerodynamics of three-surface aircraft concepts.** J. W. Agnew, G. W. Lyerla (McDonnell Aircraft Co., St. Louis, Mo.), and S. B. Grafton (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 211-221. 8 refs. (AIAA 80-1581)

It is noted that most modern fighter aircraft rely on vortex interaction to provide lift enhancement at maneuvering angles of attack. It is shown that the close-coupled horizontal canard in a

three-surface configuration provides a control surface which in addition to its other control functions, can be used to optimize this vortex interaction. Attention is given to a study intended to provide a detailed understanding of the aerodynamics of this type of configuration. The discussion examines the results of this investigation and hypotheses are presented to explain the linear and nonlinear aerodynamic phenomena observed. M.E.P.

A80-45886 # **Navy V/STOL hover and low-speed Flying Qualities Criteria - Recent developments.** J. W. Clark, Jr. (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 296-304. 17 refs. (AIAA 80-1591)

Recent developments in Flying Qualities Criteria for fixed-wing V/STOL aircraft are reviewed and summarized. The criteria considered are limited to those applicable to hover and low-speed flight (airspeeds less than approximately 35 knots in any direction). Conclusions and recommendations resulting from development programs including equivalent system analyses and control/display system trade-offs are presented. Results of both manned, ground-based simulations and in-flight investigations are included. Comparisons with the existing V/STOL Flying Qualities Specification (MIL-F-83300) and selected full scale data are made. Ongoing and future programs in the area are discussed. (Author)

A80-45887 # **A critique of handling qualities specifications for U.S. military helicopters.** D. L. Key (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 305-319. 39 refs. (AIAA 80-1592)

Inadequacies in the military specification for helicopter handling qualities, MIL-H-8501A, have long been recognized, and the latest procurements by the U.S. Army used special 'Prime Item Development Specifications' (PIDS). This paper assesses the efficacy of these 'PIDS' and suggests that changes should be made. In particular, the structure developed in MIL-F-8785B(ASG) (the specification for flying qualities of piloted airplanes) should be incorporated. Improved requirements must be based on a systematic database and concentrated on topics most important in preliminary design: static and dynamic stability, control power and sensitivity, and the interaction with controllers and displays. Emphasis should be on current military helicopter missions and helicopter idiosyncrasies such as cross-coupling, nonlinearities, and higher order dynamics. (Author)

A80-45888 # **Minimum time turns with thrust reversal.** T. L. Johnson (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and J. E. Rader (U.S. Air Force Institute of Technology, Wright-Patterson AFB, Ohio). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 320-328. 8 refs. (AIAA 80-1595)

A suboptimal control approach is used to compute minimum turn time trajectories for a hypothetical high-performance aircraft. The turn is through 180 deg and is initiated from two speeds, one below the corner speed and one above the corner speed. The value of the flight path angle at the end of the turn is constrained to be zero. The objective of the study is to determine the effect of in-flight thrust reversal on turning performance. The results compare the minimum turning time and the change in specific energy during the turn for two values of minimum available thrust. The values of the minimum available thrust correspond to 60% thrust reversal and idle or zero thrust. The study concludes that, while the ability to instantaneously change engine thrust enhances the turning performance, the value of the minimum available thrust does not significantly affect minimum turning time although it does have an effect on the change in specific energy. (Author)

A80-45889 # **Optimization of tactical aircraft maneuvers utilizing high angles of attack.** K. H. Well (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 329-336. 5 refs. (AIAA 80-1596)

Future high performance aircraft will have high thrust/weight ratios, be equipped with CCV technology, will be extremely light weight, and possibly have the capability of flying at very high angles of attack - in the 'Poststall' (PST) region. The paper investigates by using numerical optimization techniques whether the PST-capability improves performance for several tactical maneuvers. Minimum time turning maneuvers for a variety of boundary conditions and flight path constraints are computed: (1) for aircraft A which has PST-capability; (2) for aircraft B which does not but is otherwise identical with A. It is concluded that for two combinations of boundary conditions/path constraints, flight time can be reduced if high angles of attack-are utilized. In the majority of cases, however, minimum time maneuvers are flown - load constraints permitting - at or near C(Lmax). (Author)

A80-45890 # **An approximate feedback solution of a variable speed non-linear pursuit-evasion game between two airplanes in a horizontal plane.** N. Farber (Israel Military Industries, Israel) and J. Shinar (Technion - Israel Institute of Technology, Haifa, Israel). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 337-347. 23 refs. Contract No. F49620-79-C-0135. (AIAA 80-1597)

A non-linear pursuit evasion game between two variable speed airplanes in a horizontal plane (with capture time as pay-off) is analyzed by applying the technique of forced singular perturbations (FSPT). Using realistic aerodynamic and thrust data, an approximate feedback solution is obtained. For large initial separations, players' strategies consist of an initial turn followed by an accelerating dash in a 'tail chase' situation. Time optimality of the turning subarc is achieved by proper trade-off between lateral and longitudinal accelerations. A numerical example confirms the validity of the FSPT assumptions. (Author)

A80-45891 # **Preliminary analysis of minimum time and minimum noise landing approach trajectories.** H. Ohta (Nagoya University, Nagoya, Japan). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 348-357. 16 refs. (AIAA 80-1598)

Optimal control theory is used to determine thrust and glide path angle programs for minimum time and minimum noise landing approaches of aircraft modeled by approximated point-mass dynamics. Necessary conditions for optimum programs are derived and numerical results presented for a jet fighter. The minimum time solution indicates: (1) thrust is a dominant control, and glide path angle gamma has little influence on the performance index; and (2) optimum path mainly consists of a descending segment with a constant velocity, which is a singular solution, and a decelerating segment with gamma(max). The minimum noise solution indicates: (1) optimum thrust has neither its maximum nor its minimum, and varies continuously and (2) optimum path consists of a decelerating segment with gamma(max) and a descending one with gamma(min). (Author)

A80-45892 # **Bifurcation analysis of aircraft high angle-of-attack flight dynamics.** R. K. Mehra and J. V. Carroll (Scientific Systems, Inc., Cambridge, Mass.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 358-371. 25 refs. (AIAA 80-1599)

A new approach is presented for analyzing nonlinear and high-alpha dynamic behavior and stability of aircraft. This approach involves the application of bifurcation analysis and catastrophe theory methodology (BACTM) to specific phenomena such as stall, departure, spin entry, flat and steep spin, nose slice, and wing rock. Quantitative results of a global nature are presented, using numerical techniques based on parametric continuation. It is shown how BACTM provides a complete representation of the aircraft equilibrium and bifurcation surfaces in the state-control space, using a rigid body model and aerosurface controls. Also presented is a particularly useful extension of continuation methods to the detection and stability analysis of stable attracting orbits (limit cycles). The use of BACTM for understanding high-alpha phenomena, especially spin-related behavior, is discussed. (Author)

A80-45893 * # **Pseudosteady state analysis of nonlinear aircraft maneuvers.** J. W. Young, A. A. Schy, and K. G. Johnson (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 372-382. 13 refs. (AIAA 80-1600)

An analytical method has been developed for studying the combined effects of rotational coupling and nonlinear aerodynamics on aircraft response for specified control inputs. The method involves the simultaneous solution of two nonlinear equations which are functions of angle of attack, roll rate, and the control inputs. The method is applied to a number of maneuvers for a fighter type aircraft. Time history responses verified the usefulness of the analysis for predicting a variety of response characteristics caused by interacting nonlinear aerodynamic and inertial effects, including spin conditions. (Author)

A80-45894 * # **A variational technique for smoothing flight-test and accident data.** R. E. Bach, Jr. (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 383-391. 16 refs. (AIAA 80-1601)

The problem of determining aircraft motions along a trajectory is solved using a variational algorithm that generates unmeasured states and forcing functions, and estimates instrument bias and scale-factor errors. The problem is formulated as a nonlinear fixed-interval smoothing problem, and is solved as a sequence of linear two-point boundary value problems, using a sweep method. The algorithm has been implemented for use in flight-test and accident analysis. Aircraft motions are assumed to be governed by a six-degree-of-freedom kinematic model; forcing functions consist of body accelerations and winds, and the measurement model includes aerodynamic and radar data. Examples of the determination of aircraft motions from typical flight-test and accident data are presented. (Author)

A80-45895 * # **Determination of instrumentation errors from measured data using maximum likelihood method.** D. A. Keskar (SDC Integrated Services, Inc., Hampton, Va.) and V. Klein (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 392-396. 9 refs. Grant No. NCC1-29. (AIAA 80-1602)

The maximum likelihood method is used for estimation of unknown initial conditions, constant bias and scale factor errors in measured flight data. The model for the system to be identified consists of the airplane six-degree-of-freedom kinematic equations, and the output equations specifying the measured variables. The estimation problem is formulated in a general way and then, for practical use, simplified by ignoring the effect of process noise. The algorithm developed is first applied to computer generated data having different levels of process noise for the demonstration of the robustness of the method. Then the real flight data are analyzed and the results compared with those obtained by the extended Kalman filter algorithm. (Author)

A80-45902 # **Helicopter stability and control test methodology.** B. B. Blake and K. Lunn (Boeing Vertol Co., Philadelphia, Pa.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 456-464. (AIAA 80-1610)

This paper reviews the techniques employed at Boeing Vertol to predict helicopter behavior for the frequency spectrum progressing from quasi-static through piloted flight dynamics to rotor order modes. Material covered includes flying qualities and aeromechanical stability testing of a Bearingless Main Rotor helicopter. Techniques for in-flight determination of rotor modal damping and progress on use of a NASA/Army developed parameter identification program are discussed. Prediction methods, build up techniques, and test monitoring for such potentially hazardous tests as height velocity determination and external sling load stability are examined. A forecast is made of advances to be expected in the near future. (Author)

A80-45903 * # **A direct method for synthesizing low-order optimal feedback control laws with application to flutter suppression.** V. Mukhopadhyay, J. R. Newsom, and I. Abel (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 465-475. 15 refs. (AIAA 80-1613)

A direct method of synthesizing a low-order optimal feedback control law for a high order system is presented. A nonlinear programming algorithm is employed to search for the control law design variables that minimize a performance index defined by a weighted sum of mean square steady state responses and control inputs. The controller is shown to be equivalent to a partial state estimator. The method is applied to the problem of active flutter suppression. Numerical results are presented for a 20th order system representing an aeroelastic wind-tunnel wing model. Low-order controllers (fourth and sixth order) are compared with a full order (20th order) optimal controller and found to provide near optimal performance with adequate stability margins. (Author)

A80-45904 # **The effects of inhomogeneities in atmospheric turbulence on the dynamic response of an aircraft.** G. Treviño (Del Mar College, Corpus Christi, Tex.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 476-481. (AIAA 80-1614)

The power-spectral density of the dynamic response of an aircraft to inhomogeneous turbulence is formulated. In order to facilitate the analysis of the response the inhomogeneous turbulence is decomposed into two parts - a part whose statistics, viz. the scale and the intensity, are spatially constant and a part whose statistics are spatially varying. The effects of the inhomogeneities on the response are analyzed through a 'correction factor' whose numerical value is a measure of the percent error introduced into the response power-spectrum whenever the effects of the inhomogeneities are neglected. Numerical results are obtained for the cases of an airplane flying through turbulence whose intensity varies sinusoidally in space and an airplane flying through turbulence whose integral scale varies sinusoidally in space. (Author)

A80-45905 # **Time-domain computation of aircraft gust covariance matrices.** U.-L. Ly (Boeing Commercial Airplane Co., Seattle, Wash.) and Y. K. Chan (Boeing Computer Services Co., Seattle, Wash.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 482-491. 9 refs. (AIAA 80-1615)

A method for direct computation of response correlation matrices for flexible aircraft excited by three-dimensional random turbulence is presented. The calculations are exact for typical turbulence spectra and employ pure time delays to represent gradual gust penetration. This approach is more efficient than the usual numerical integration of output power spectra, in particular for models of flexible aircraft with lightly damped structural modes that are excited by distributed gust inputs. Turbulence models such as white-noise, Dryden and von Karman are considered. In addition to state and measurement responses, dynamic loads, surface activities and characteristic frequencies are readily computed. (Author)

A80-45907 * # Model development for automatic guidance of a VTOL aircraft to a small aviation ship. T. Goka, J. A. Sorensen, S. F. Schmidt (Analytical Mechanics Associates, Inc., Mountain View, Calif.), and C. H. Paulk, Jr. (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 497-505. 10 refs. Contract No. NAS2-10288. (AIAA 80-1617)

This paper describes a detailed mathematical model which has been assembled to study automatic approach and landing guidance concepts to bring a VTOL aircraft onto a small aviation ship. The model is used to formulate system simulations which in turn are used to evaluate different guidance concepts. Ship motion (Sea State 5), wind-over-deck turbulence, MLS-based navigation, implicit model following flight control, lift fan V/STOL aircraft, ship and aircraft instrumentation errors, various steering laws, and appropriate environmental and human factor constraints are included in the model. Results are given to demonstrate use of the model and simulation to evaluate performance of the flight system and to choose appropriate guidance techniques for further cockpit simulator study. (Author)

A80-45908 # Validation of a wing leading edge stall prediction technique. J. Pavelka and K. E. Tatum (McDonnell Aircraft Co., St. Louis, Mo.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 506-514. 5 refs. (AIAA 80-1620)

The objective of this research was to design a model wing using previously developed two dimensional computational techniques for prediction of airfoil leading edge laminar separation. The wing was designed employing various criteria with the primary objective being to maximize the wing lift coefficient at which drag rise is caused by leading edge separation. The model wing was fabricated for test in the McDonnell Douglas Corporation Polysonic Wind Tunnel. The test results compared well with the predicted values and demonstrated substantial improvement in leading edge separation lift coefficient over a previously tested wing designed without benefit of the laminar separation computation technique. (Author)

A80-45909 # Moving surface boundary layer control for aircraft operation at high incidence. V. J. Modi, J. L. C. Sun, T. Akutsu, P. Lake, K. McMillan, P. G. Swinton, and D. Mullins (British Columbia, University, Vancouver, Canada). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 515-522. 26 refs. Natural Sciences Engineering Research Council of Canada Grant No. A-2181. (AIAA 80-1621)

The paper studies effectiveness of the moving surface boundary layer control on a NACA 63-218 (modified) two dimensional wing used in the Canadair CL-84, a twin propeller V/STOL design. Tests with rotating cylinder(s) at leading edge of the airfoil and/or of the flap show the former to have a significant effect on the maximum lift, stall characteristics and lift/drag ratio. On the other hand, the advantage gained by the presence of the rear cylinder is relatively small for the slotted flap configuration. The availability of a high value of lift suggests the approach velocity with this form of boundary layer control is likely to be limited only by the lateral-directional stability characteristics. The concept presents several possible applications including a mechanism for delaying vortex induced resonance of bluff bodies. (Author)

A80-45911 * # Effects of wing and tail location on the aerodynamic characteristics of an airplane for Mach numbers from 0.25 to 4.63. M. L. Spearman (NASA, Langley Research Center, Aeronautical Systems Div., Hampton, Va.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 529-535. (AIAA 80-1623)

An experimental investigation was conducted to determine the effect of wing vertical position and horizontal-tail vertical and axial position on the static aerodynamic characteristics of a wing-body-horizontal-tail configuration. The configurations investigated included the wing in a high, mid, or low position on the body with the horizontal tail in each of these vertical positions as well as in three axial positions. The closest position of the horizontal tail to the wing essentially provided an all-wing configuration. In addition, tests were made for the three wing positions with the horizontal tail removed. The tests were made in three different wind tunnels to provide data for a Mach number range from 0.25 to 4.63. The purpose of the investigation was to illustrate the strong effects of interference flow fields as a function of geometry and flight attitude and to provide a systematic data base that might be useful for correlation with various analytical techniques. The results indicate some arrangements that might lead to aerodynamic problems and others in which the interference flow fields might be favorably exploited. The results suggest that a coplanar concept with a translating horizontal tail could potentially minimize the aerodynamic changes with Mach number and provide more optimum performance over the Mach number range. (Author)

A80-45912 * # A pilot modeling technique for handling-qualities research. R. A. Hess (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 536-549. 31 refs. (AIAA 80-1624)

A brief survey of the more dominant analysis techniques used in closed-loop handling-qualities research is presented. These techniques are shown to rely on so-called classical and modern analytical models of the human pilot which have their foundation in the analysis and design principles of feedback control. The optimal control model of the human pilot is discussed in some detail and a novel approach to the a priori selection of pertinent model parameters is discussed. Frequency domain and tracking performance data from 10 pilot-in-the-loop simulation experiments involving 3 different tasks are used to demonstrate the parameter selection technique. Finally, the utility of this modeling approach in handling-qualities research is discussed. (Author)

A80-45913 # An experimental investigation of VTOL flying qualities requirements in shipboard landings. R. C. Radford and D. Andrisani, II (Calspan Advanced Technology Center, Buffalo, N.Y.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 550-560. 11 refs. Contract No. N62269-78-C-0043. (AIAA 80-1625)

This in-flight simulation experiment, using the U.S. Navy X-22A variable stability V/STOL aircraft operated by Calspan, was undertaken to generate data for the development of flying qualities and flight control system design criteria for hover and low speed flight. In particular, the experiment emphasizes the flying qualities characteristics of inertial translational rate control systems in the context of the visual landing mission aboard small aviation-capable ships under high wind-over-deck and sea-state conditions. Preliminary pilot rating

data indicate that with suitable command gains, velocity response time constants up to about 2.5 seconds provide satisfactory flying qualities. Minimum and maximum satisfactory command gains were determined for a range of velocity time constants. (Author)

A80-45914 * # **A summer of an in-flight evaluation of control system pure time delays during landing using the F-8 DFBW airplane.** D. T. Berry, B. G. Powers, K. J. Szalai, and R. J. Wilson (NASA, Flight Research Center, Edwards, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 561-571. 8 refs. (AIAA 80-1626)

An in-flight investigation of the effect of pure time delays on low L/D space shuttle type landing tasks was undertaken. The results indicate that the sensitivity of the pilot ratings to changes in pure time delay in pitch is strongly affected by the task and only slightly affected by changes in control system augmentation mode. Low L/D spot landings from a lateral offset were twice as sensitive to pure time delay as normal low L/D landings. For comparison purposes, formation flying was also investigated, and was found to be less sensitive to time delay than the landing tasks. (Author)

A80-45915 * # **Low order equivalent models of highly augmented aircraft determined from flight data using maximum likelihood estimation.** M. F. Shafer (NASA, Flight Research Center, Edwards, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 572-582. 11 refs. (AIAA 80-1627)

This paper presents the results of a study of the feasibility of using low order equivalent mathematical models of a highly augmented aircraft, the F-8 digital fly-by-wire (DFBW), for flying qualities research. Increasingly complex models were formulated and evaluated using flight data and maximum likelihood estimation techniques. The aircraft actuator was modeled alone first. Next the equivalent derivatives were used to model the longitudinal unaugmented F-8 DFBW aircraft dynamics. The most complex model incorporated a pure time shift of the pilot input, a first order lag, and the basic longitudinal airframe model. This same model was then implemented for the F-8 DFBW aircraft in a highly augmented mode. Excellent matching of the dynamics resulted for this model, indicating that low order equivalent models which are good representations of the highly augmented F-8 DFBW aircraft can be formulated with these methods. (Author)

A80-45916 * # **Flying-qualities criteria for wings-level-turn maneuvering during an air-to-ground weapon delivery task.** R. I. Sammonds (NASA, Ames Research Center, Moffett Field, Calif.) and J. W. Bunnell, Jr. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 583-595. (AIAA 80-1628)

A moving-base simulator experiment conducted at Ames Research Center demonstrated that a wings-level-turn control mode improved flying qualities for air-to-ground weapons delivery compared with those of a conventional aircraft. Evaluations of criteria for dynamic response for this system have shown that pilot ratings correlate well on the basis of equivalent time constant of the initial response. Ranges of this time constant, as well as digital-system transport delays and lateral-acceleration control authorities that encompassed Level I through Level III handling qualities, were determined. (Author)

A80-45917 # **Quantification of V/STOL equivalent system characteristics through analysis and ground-base simulation.** C. G. Carpenter, J. Hodgkinson (McDonnell Aircraft Co., St. Louis, Mo.), and J. W. Clark, Jr. (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 596-607. 14 refs. (AIAA 80-1629)

The paper evaluated the high and low frequency terms added to hover attitude systems with respect to their base handling qualities simulation. The evaluation determined (1) the pilot's frequency range of interest, (2) the maximum allowable mismatch between high order systems and their low order equivalents, (3) acceptability of high-order-appearing responses, and (4) the piloting effects of phase lag at the natural frequency vs time delay. The high order dynamics were analytically matched by equivalent low order systems, whose parameters were then compared to flying qualities criteria. A.T.

A80-45918 * # **Determination of an oblique wing aircraft's aerodynamic characteristics.** R. H. Travassos, N. K. Gupta (Systems Control, Inc., Palo Alto, Calif.), K. W. Iliff, and R. Maine (NASA, Flight Research Center, Edwards, Calif.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 608-618. Contract No. NAS4-2682. (AIAA 80-1630)

In this paper, the integration of wind tunnel and flight test procedures are studied for specifying aerodynamic model forms. A procedure is described which employs a stepwise regression method to systematically determine model structures and F-ratio statistics to rank the importance of each aerodynamic coefficient within a given model. Application of this technique and wind tunnel procedures to an oblique-wing aircraft indicate that the aircraft's measured and estimated response are in good agreement at both small and large wing skew angles. (Author)

A80-45919 # **The EBM system identification technique and its application to high alpha/beta-modeling of aircraft.** H. L. Stalford (Dynamics Research Corp., Wilmington, Mass.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 619-625. 24 refs. Navy-supported research. (AIAA 80-1631)

This paper discusses the Estimation-Before-Modeling (EBM) System Identification Technique method and its application to high alpha/beta Modeling of Aircraft. The EBM technique is a two-step approach to the identification of nonlinear aircraft aerodynamics. In the first step flight data is processed by an extended Kalman-Bucy filter/Bryson-Frazier smoother to generate smoothed estimates of the states, aerodynamic forces and moments time histories, and measurement biases and scale factors. Gauss-Markov processes are used in the first step to model the accelerations due to aerodynamic forces and moments. In the second step which is the modeling part, the Stepwise Multiple Linear Regression (SMLR) method is used together with subspace modeling and global model synthesis to identify the nonlinear dependency of the aerodynamic coefficients on aircraft states and controls. (Author)

A80-45920 # **An adaptive controller synthesis with an observer.** K. Kanai, T. Degawa (Defense Academy, Dept. of Aeronautical Engineering, Yokosuka, Kanagawa, Japan), P. N. Nikiforuk, and M. M. Gupta (Saskatchewan, University, Saskatoon, Canada). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 626-631. 6 refs. (AIAA 80-1632)

This paper deals with the problem of designing a model reference adaptive controller with an observer for a linear discrete system where only the input and the output can be measured. An adaptive observer which is constructed by introducing unknown initial states into the recursive algorithm is employed to estimate the parameters and the state variables of the plant, and these estimates, in turn, are used to adjust the parameters of a controller. The

adaptive controller is synthesized such that the tracking error between the output of the controlled system and that of a prespecified linear reference model is regulated to zero asymptotically. The proposed controller has simple structure with the determined convergence rate not effected by the relative degree of the plant. The feasibility of the proposed scheme was demonstrated by applying this to the adaptive controller design of an airplane and the computational results for identifying unknown stability and control derivatives with inaccessible state variables are obtained and the good tracking performances are concluded. (Author)

A80-45921 * # **Identification of flexible aircraft from flight data.** B. J. Eulrich and E. G. Rynaski (Calspan Advanced Technology Center, Buffalo, N.Y.). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 632-649. 16 refs. NASA-supported research; Contract No. F33615-78-C-3602. (AIAA 80-1633)

This paper describes a frequency-domain method for the estimation of the aeroelastic equations of motion of an aircraft using discrete sinusoidal inputs to the control surface actuators. The theory of estimation of the signal inputs and outputs is described as well as the method of obtaining accurate transfer functions from the resulting Bode plots. Methods of quantifying the accuracy of the results from more than one control input are discussed along with ways to obtain state-space and reduced-order models from the transfer function estimates. Presented is a summary of the results obtained in using the technique to develop a model of the USAF Total In-Flight Simulator (TIFS) aircraft which includes five symmetrical elastic modes of motion of the aircraft. (Author)

A80-45922 # **Identification of aeroelastic parameters using a recursive sequential least squares method.** R. C. Schwanz (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and W. R. Wells (Wright State University, Dayton, Ohio). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 650-661. 14 refs. (AIAA 80-1634)

A new time domain procedure that identifies aeroelastic parameters from flight test sensor measurements is developed and then illustrated with a numerical simulation of the B-52E CCV aircraft. The solution depends upon a satisfactory reduction of the order of the state equation and an appropriate selection of the control surface input disturbance to the system. The suitability of the order reduction and control inputs is ensured by forcing a newly defined 'measurement residual' to be small with respect to other terms in the measurement equation. It is shown that the measurement residual may be used to prevent instability and inaccuracy in the identification algorithm. (Author)

A80-45923 # **Parameter identification of B-52E CCV flight test data including aeroelastic effects.** R. C. Schwanz (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and G. L. Grimes (USAF, ASD Computer Center, Wright-Patterson AFB, Ohio). In: Atmospheric Flight Mechanics Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 662-676. 13 refs. (AIAA 80-1635)

The paper summarizes the results of identifying aerodynamic and aeroelastic parameters of the B-52E CCV aircraft from the flight test data. The identification is accomplished using a recursive sequential least squares method and assumes that the aircraft dynamics reflect either perfect rigidity, static elasticity or residual elasticity. With the residual elastic assumption, the possibility of a nonlinear, limit cycle dynamic motion is considered. It is shown that the critical aeroelastic parameters associated with static longitudinal stability and control and structural dynamic damping and control may be identified from flight data. (Author)

A80-46009 **High modulus/high strength organic fibers.** W. B. Black (Monsanto Textiles Co., Pensacola, Fla.). In: Annual review of materials science. Volume 10. Palo Alto, Calif., Annual Reviews, Inc., 1980, p. 311-362. 171 refs.

A review of recent developments in high modulus-high strength organic fibers is presented. Synthetic organic fibers with specific tensile stiffness more than three times that of E-glass filaments are now available commercially; aromatic polymer-based fibers have specific strengths up to five times that of high strength steel wire. The high modulus aromatic fibers were followed by development of polyethylene (PE) with specific tensile moduli twice that of glass fibers; recently filaments with tensile moduli twice that of glass fibers was reported. The aromatic fibers are based on polymers that are rod-like which yield anisotropic or liquid crystalline solutions making possible certain combinations of strength and stiffness in the fibers. The aromatic high-modulus fibers are used as replacements for E-glass for nonstructural aircraft parts; high modulus PE fibers have poor dead load strength due to propensity to creep, but are of considerable theoretical interest because it is a flexible polymer that crystallizes in the form of folded chains which can be fabricated by drawing, extrusion, or threadlike crystallization from solutions. A.T.

A80-46064 **Application of electromagnetic methods and means of nondestructive inspection in series production of aircraft.** P. S. Tiukhtin (Kuibyshev Aircraft Plant, Kuibyshev, USSR). *(Defektoskopiia,* vol. 16, Jan. 1980, p. 48-55.) *Soviet Journal of Nondestructive Testing,* vol. 16, no. 1, Sept. 1980, p. 35-40. 10 refs. Translation.

Trends in the electromagnetic flaw detection and thickness measurement are reviewed with particular reference to the inspection of aircraft parts and assemblies. One of the trends is the use of multielement transducers and multichannel systems to insure simpler scanning trajectories and sufficient rates of inspection. Electromagnetic inspection is used essentially to detect fatigue cracks and discontinuities of technological origin in skin, mountings of the power plant, thrust rings, spar flanges, and dismountable profiles. The electromagnetic thickness measurement of chromium plating and dielectric coatings up to 250 microns is also discussed. Studies are carried out with a view to designing an electromagnetic instrument for measuring the thickness of nitrided and case-hardened layers. V.L.

A80-46136 **Adaptive main-beam nulling for narrow-beam antenna arrays.** R. N. Adams, L. L. Horowitz, and K. D. Senne (MIT, Lexington, Mass.). *(Workshop on Applications of Adaptive Control, New Haven, Conn., Aug. 1979.) IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-16, July 1980, p. 509-515. 8 refs. USAF-supported research.

Narrow-beam, low-sidelobe antennas may be used to enhance communication in the presence of sidelobe interferers. Protection against main-beam interferers as well can be obtained through the use of an adaptive multibeam antenna. Such an antenna, suitable for time-multiplexed, multichannel signals is described here. The objective is to permit successful communication and signal direction-of-arrival tracking in the presence of a large number of sidelobe interferers and a small number of main-beam interferers. (Author)

A80-46227 # **Structures of flow separations over swept wings (Structures des décollements sur les ailes en flèche).** H. Werlé (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine; France). *La Recherche Aérospatiale,* Mar.-Apr. 1980, p. 85-108. 32 refs. In French. (ONERA, TP No. 1980-27)

The systematic study of the singularities characterizing the various types of separations which develop over swept wings, particularly at high angles of attack, has recently been resumed at ONERA by means of flow visualizations at the water tunnel. From the set of these results, obtained at low speed, a number of fundamental schemes can be derived that emphasize the complex vortex structure of these phenomena from their formation more or less close to the apex until their disorganization downstream. This

analysis, which distinguishes full wings and wall-mounted half wings, covers the effects due to the main parameters of flow, aircraft configuration and wing shape. (Author)

A80-46230 # **Aircraft radar echoes characterization (Caractérisation des échos radar sur les aéronefs).** C. Pouit (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aérospatiale*, Mar.-Apr. 1980, p. 131-139. In French. Research supported by the Direction des Recherches, Etudes et Techniques. (ONERA, TP No. 1980-30)

Electromagnetic wave diffraction and reflection theories enable prediction of most of the effects generated by radar echoes on aircraft. However, it is difficult to modelize some complex effects originating in canopies, radomes and cavities. In order to supplement the present theoretical knowledge by experimental results obtained on actual targets, ONERA has developed a novel analysis method allowing the generation of radar images. This method provides an efficient working tool to assist in defining radar wise discrete aerial targets. (Author)

A80-46277 # **Status and prospects of the Airbus family program (Stand und Chancen des Airbus - Familien Programms).** H. Flosdorff (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-020.* 53 p. In German.

The current status of the Airbus A300 versions is reviewed from the technological, production, and marketing points of view. Owing to efficient planning and adaptation to the European market, the stagnation point of 1976 has been replaced by rapid growth in demand. Thirty three major airlines are among the customers for the airbus A300, and a number of sales have been concluded for the A310, even though its completion is expected in 1983. V.P.

A80-46278 # **The Alpha-Jet at introduction (Alpha Jet in der Einführung).** P. Kania (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-022.* 53 p. In German.

The trainer and fighter-bomber versions of the Alpha Jet aircraft are described, along with the major program developments over the period from 1970 to 1980. The potentials of the Alpha Jet with respect to adaptation to new sophisticated weapons and to applications more stringent than those foreseen in the design are examined. Some component testing programs and their influence on Alpha Jet design are noted. V.P.

A80-46280 # **Technological advances in the light of operational cost policies (Technologische Fortschritte im Spiegel der Betriebskostenverfahren).** B. Fischer (Messerschmitt-Bölkow-Blohm GmbH, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-025.* 21 p. In German.

Following a brief discussion of the factors influencing aircraft operational costs and of the relative importance of these factors, examples are used to demonstrate the effects of various advanced technologies on the cost effectiveness of an airliner. Some key areas where R & D work may lead to economically attractive aircraft designs are noted. V.P.

A80-46281 # **Calculation of unsteady transonic aerodynamic forces on a three-dimensional wing (Berechnung von instationären transsonischen Luftkräften an einem 3-D Flügel).** K. Dau and H. Zimmermann (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-027.* 40 p. 10 refs. In German. Bundesministerium der Verteidigung Contract No. T/RF-41/80049/81448.

A method is proposed for calculating the unsteady pressure distribution over large-aspect-ratio wings at transonic speeds. In this method, the unsteady-state potential equation for small disturbances is solved for a given profile by means of a finite-difference scheme. The three-dimensional effects for a large-aspect-ratio wing are handled with the aid of subsonic corrections. V.P.

A80-46283 # **Instationary air forces on wings with an oscillating rudder (Instationäre Luftkräfte an Tragflächen mit schwingendem Ruder).** W. Geissler (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aeroelastik, Göttingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-031.* 29 p. 15 refs. In German.

It is noted that future aircraft will make greater use of active control to counteract problems such as gust load reduction, maneuver load control, flutter suppression, etc. Attention is given to the need for detailed knowledge of the instationary air forces of rapidly moved controlled surfaces as a prerequisite for an optimal and safe construction. The status of theoretical work at the DFVLR in the area of instationary aerodynamics of air foils with oscillating trailing edge flaps is reported and comparisons with the results are made. Finally future developments are considered. M.E.P.

A80-46284 # **Some aspects of airframe/engine interference for single-jet afterbodies and engine nacelles with particular consideration of boattail drag (Einige Aspekte der Zellen-Triebwerksinterferenz bei einstrahligen Heckkörpern und Triebwerksgondeln unter besonderer Berücksichtigung des Heckdruckwiderstands).** H. Riedel (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Entwurfs-Aerodynamik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-032.* 38 p. 10 refs. In German.

The experiments described were carried out to study the physical relationships and principal factors affecting boattail drag and flow separation in the case of cold jet simulation. The influence of the simulation of actual jet effects, in particular, of the jet temperature and nacelle-wall temperature, is determined. V.P.

A80-46285 # **Technological and commercial aspects of aircraft production (Technische und wirtschaftliche Probleme der Fertigung im Flugzeugbau).** M. Dronsek (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-033.* 17 p. In German.

A major objective of the present paper is to demonstrate the advantages which accrue from the application of the Computerized Integrated and Automated Manufacturing (CIAM) system to the production of the A300 and A310 aircraft. The commercial aspects of production integration and automation are examined, along with the influence of national price increases and changes in rate of exchange on the production costs of a European Aircraft Program. V.P.

A80-46286 # **Profile cutting with direct data allocation and real-time operations planning (Formfrästeil-Fertigung mit direkter Datenzuteilung und Echtzeitbelegungsplanung).** H. Becker and U. Grupe (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-035.* 35 p. In German.

The paper deals essentially with the automation of the profile cutting process in the production of aircraft and spacecraft structures. Some aspects of providing input data for digital control are examined. V.P.

A80-46288 # **Influence of the design on the cost, using the Airbus and the Ariane booster as examples (Einfluss der Konstruktion auf die Kosten am Beispiel des Grossraumflugzeuges Airbus und der Trägerrakete Ariane).** W. Zabka (Messerschmitt-Bölkow-Blohm

GmbH, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-037.* 35 p. In German.

The various factors which influence aircraft cost are examined, with particular reference to the influence of the aircraft design. Some principles of rational cost-effective design are demonstrated for a large aircraft and a multistage booster. V.P.

A80-46289 # **Cost effective series production on the basis of new design and production principles, using a light aircraft as an example (Wirtschaftliche Serienfertigung durch neue Konstruktions- und Fertigungsprinzipien am Beispiel eines modernen Leichtflugzeuges).** A. Schneider (Rhein-Flugzeugbau GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-038.* 23 p. In German.

A short introductory review of some aspects of light-aircraft production in Europe is followed by a description of procedures for obtaining the final design version and the rational production technology for Fantrainer 400 aircraft. The development of the aircraft systems, subsystems, and elements and their cost analysis are examined. V.P.

A80-46295 The linking of development problems with the example of thrust reversal and landing gear loads (Die Verknüpfung von Entwicklungsproblemen am Beispiel von Schubumkehr und Fahrwerkslasten). A. Krauss (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-045.* 31 p. In German. (MBB-FE-224/S/PUB/29)

Equipping combat aircraft with thrust reversal results in a substantial reduction in the landing distance. It is shown that in spite of extensive model measurements, development problems can occur which can be traced to an instable behavior of the reversed thrust. In order to solve such problems the other components of the aircraft must be matched accordingly. Attention is given to the example of thrust reversal and landing loads in which the matching of the landing gear is emphasized. M.E.P.

A80-46296 # **Protection against wing icing for airbus A300 and A310 (Vereisungsschutz für die Traglächen des Airbus A300 and A310).** G. Wölfer (Messerschmitt-Bölkow-Blohm GmbH, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-046* 34 p. In German.

To improve economy of operation, it is now planned to modify the antiicing system used on the A300 airbus wing. Thus, for the A310 airbus, the deicing system will be applied to only half the wing length. Other essential modifications are a substantial simplification of the warm-air system and discontinuation of the use of a double wall in slats. V.P.

A80-46297 # **Takeoffs and wave-offs under the influence of wind shear (Start und Durchstart unter Scherwindeinfluss).** R. König and P. Krauspe (Braunschweig, Technische Universität, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-047.* 27 p. 6 refs. In German.

On the basis of a discussion of existing take-off regulations, it is shown to what extent certain meteorological conditions can affect flight efficiency and, hence, flight safety. The effects of wind shear are analyzed and are shown to differ for aircraft performance in takeoff and wave-off. Means of compensating for wind shear in the take-off and wave-off modes of flight are proposed. V.P.

A80-46298 # **New tasks and progressive integration in the area of flight and power plant control (Neue Aufgaben und fortschreitende Integration auf dem Gebiet der Flug- und Triebwerksregelung).** G. Dahl, V. Krebs, and P. Wüst (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-048.* 19 p. 11 refs. In German.

Owing to changes in economic considerations and boundary conditions, the totality of control and guidance tasks is no longer treated as a sum of individual tasks, but rather in the sense of optimizing the system as a whole. Typical examples are the integration of engine control tasks and the linking of flight and engine control. In the present paper, attention is focused on the integration of flight path optimization, engine regulation, and flight control, on digital engine regulation, and on means of eliminating, or at least reducing, the effects of turbulence and wind gusts on aircraft flight. V.P.

A80-46299 # **Digital electrohydraulic control surface actuator, positioned by means of quick-acting solenoid valves (Digitaler elektrohydraulischer Ruderstellantrieb mit Ansteuerung durch schnellschaltende Magnetventile).** G. Mansfeld and J. Tersteegen (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-050.* 26 p. In German.

The design, principle, and control circuit of a digital electrohydraulic control surface actuator are discussed, using a modified F104 horizontal surface actuator as an example. The static and dynamic characteristics of the digital actuator are discussed, and its excellent performance is demonstrated. V.P.

A80-46300 # **Concept of a research aircraft for remote sensing, using an integrated sensor/data system (Konzept eines Forschungsflugzeuges für die Fernerkundung mit integriertem Sensor- und Datensystem).** G. Miosga (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Optoelektronik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-051.* 34 p. In German.

The paper deals with a concept for defining an experimental aircraft for earth resource surveys. The mission requirements are formulated, and the determination of the type of aircraft best suited to meet these requirements is discussed, along with the onboard data-acquisition and sensor systems. V.P.

A80-46303 # **Modern maintenance of transport aircraft (Moderne Wartung von Transportflugzeugen).** K. H. Galda (Deutsche Lufthansa AG, Hamburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 13th, Braunschweig, West Germany, May 28-30, 1980, Paper 80-057.* 24 p. In German.

The paper deals with an investigation carried out by Lufthansa in cooperation with Boeing on the basis of inspection periods developed for the Boeing 727 and 707 aircraft. The model derived is applied (purely theoretically) to the Boeing 727. From this application, it can be seen that operational experience with a large fleet over 12 years makes it possible to establish the first and following inspection periods, neglecting the lead fleet. This procedure cannot be applied to the Airbus A300 in view of insufficient operational experience. V.P.

A80-46366 # **Measurement of the Reynolds stress tensor using a single rotating slanting hot wire.** G. De Grande and Ch. Hirsch (Brussel, Vrije Universitiet, Brussels, Belgium). *Archiwum Mechaniki Stosowanej*, vol. 32, no. 1, 1980, p. 21-32. 6 refs.

Measurements of the six components of the Reynolds stress tensor in a curved duct experiment are reported. The method used is a single rotating slanting hot wire technique. The duct was so constructed that the decay in the outlet section was complete. The most important conclusion from the measurements is that the

models describing the turbulent stresses should take into account the history effect of the flow. (Author)

A80-46411 * # **Endurance and failure characteristics of modified Vasco X-2, CBS 600 and AISI 9310 spur gears.** D. P. Townsend and E. V. Zaretsky (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, International Power Transmission and Gearing Conference, 3rd, San Francisco, Calif., Aug. 18-22, 1980, Paper.* 27 p. 15 refs.

Gear endurance tests and rolling-element fatigue tests were conducted to compare the performance of spur gears made from AISI 9310, CBS 600 and modified Vasco X-2 and to compare the pitting fatigue lives of these three materials. Gears manufactured from CBS 600 exhibited lives longer than those manufactured from AISI 9310. However, rolling-element fatigue tests resulted in statistically equivalent lives. Modified Vasco X-2 exhibited statistically equivalent lives to AISI 9310, CBS 600 and modified Vasco X-2 gears exhibited the potential of tooth fracture occurring at a tooth surface fatigue pit. Case carburization of all gear surfaces for the modified Vasco X-2 gears results in fracture at the tips of the gears. (Author)

A80-46539 # **Optimal evaluation of angular coordinates of aircraft in multichannel radio direction finding (Optimal'noe otsenivanie uglovykh koordinat letatel'nogo apparata pri mnogokanal'nom radiopelengovanii).** A. S. Bogachev. *Radiotekhnika,* vol. 35, June 1980, p. 28-32. 8 refs. In Russian.

The paper presents the problem of quasioptimal processing of continuous radiosignals for the case of the antenna array of the radio direction finder of arbitrary configuration. The problem is solved using the Markov theory of nonlinear filtration in a Gaussian approximation. A.T.

A80-46548 * # **Hydrazine monopropellant reciprocating engine development.** J. W. Akkerman (NASA, Johnson Space Center, Houston, Tex.). *(American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec. 10-15, 1978, Paper 78-WA/Aero-12.) ASME, Transactions, Journal of Engineering for Industry,* vol. 101, Nov. 1979, p. 456-462.

A hydrazine-fueled piston-type engine for providing 11.2 kW (15 hp) has been developed to satisfy the need for an efficient power supply in the range from 3.7 to 74.6 kW (5 to 100 hp) where existing nonair-breathing power supplies such as fuel cells or turbines are inappropriate. The engine was developed for an aircraft to fly to 21.3 km (70,000 ft) and above and cruise for extended periods. The NASA Hugh L. Dryden Flight Research Center developed a remotely piloted aircraft and the associated flight control techniques for this application. About 20 hr of run time have demonstrated good efficiency and adequate life. One flight test to 6.1 km (20,000 ft) has been made using the engine with a small fixed-pitch four-bladed propeller. The test was successful in demonstrating operational characteristics and future potential. (Author)

A80-46680 **Digital active controls for L-1011.** *Aviation Engineering and Maintenance,* vol. 4, Apr. 1980, p. 22-25.

The paper describes the Lockheed active controls digital system (ACS) which reduces maneuver and gust loads in the extended wing of the L-1011 aircraft. The ACS performs in the same manner as the common yaw damper so that aileron deflection is automatic, fully powered, and in series with the primary controls. ACS produces fuel savings of 3 to 3 1/2%, and is a fail-operational/fail-soft system; it can be automatically or manually engaged and disengaged by means of switches in the flight deck. Lockheed expects an inflight availability of 99.9%, although in case the system becomes inoperative in flight, the aircraft can continue to its destination. A.T.

A80-46681 **Down to earth operations.** *Aviation Engineering and Maintenance,* vol. 4, Apr. 1980, p. 37-39.

The paper examines cost assessments of current air transport procedures and changes in operational practices to minimize fuel costs. The use of ground power instead of aircraft-mounted auxiliary power units for terminal operations is described which include 30 diesel units which provide compressed air to start turbine engines. Fuel savings can also be made by using fixed, centralized power distribution systems which consist of a power source, a distribution network, service cable storage and handling devices, with converters of 50 Hz utility power to 400 Hz power for the airline terminal. A.T.

A80-46682 **Airbus airfoils cut fuel burn - High aspect ratio, thickness, low sweep contribute.** *Aviation Engineering and Maintenance,* vol. 4, Apr. 1980, p. 40-43.

A80-46693 * # **VTOL in-ground effect flows for closely spaced jets.** M. J. Siclari, W. G. Hill, Jr., R. C. Jenkins, and D. Migdal (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems Meeting, Anaheim, Calif., Aug. 4-6, 1980, Paper 80-1880.* 16 p. 10 refs. Contract No. NAS2-10097.

The interaction of two vertically impinging incompressible jets is studied through the invention of physical flow models that approximate the behavior of colliding wall jets as the incident jets are brought closer together. The mechanism for upwash formation is studied and momentum models for the upwash sheet are postulated. An approximate method for computing the ground isobar pattern of jet and upwash deflection zones is presented and compared with test data. A method for computing the upwash impingement force in the absence of secondary induced flow effects is also presented and reasonably good agreement is achieved with experimental data for cylindrical fuselage shapes of circular and rectangular cross section. (Author)

A80-46826 # **Calculation of the supersonic flow past a slender delta wing at angles of attack and sideslip (Raschet sverkhzvukovogo obtekaniia tonkogo treugol'nogo kryla pod uglami ataki i skol'zheniia).** A. N. Minailos. *TsAGI, Uchenye Zapiski,* vol. 10, no. 4, 1979, p. 1-9. 5 refs. In Russian.

A method proposed by Losykh and Minailos (1977) for calculating supersonic flows past wings and lifting bodies is extended to include flows at an angle of sideslip. Flow fields and patterns are calculated for several flows involving sideslip. A classification of conical flows past slender wings is extended to flows at an angle of sideslip. V.P.

A80-46827 # **Potential flow past a wing profile with a trailing edge of finite thickness (Potentsial'noe obtekanie profilia s konechnoi tolshchinoi zadnei kromki).** G. A. Pavlovets. *TsAGI, Uchenye Zapiski,* vol. 10, no. 4, 1979, p. 10-19. 6 refs. In Russian.

The analysis deals with the pattern of potential flow past a wing profile in the presence of a finite zone of constant pressure behind the trailing edge. An exact analytical solution is obtained to the problem of axisymmetric flow past a polygonal wing profile with a trailing edge of finite thickness. The characteristics and the asymptotic behavior of the solution near the trailing edge are examined. V.P.

A80-46829 # **Contribution to the theory of hypersonic flow past three-dimensional wings (K teorii giperzvukovogo obtekaniia trekhmernykh kryl'ev).** V. N. Golubkin. *TsAGI, Uchenye Zapiski,* vol. 10, no. 4, 1979, p. 29-36. 9 refs. In Russian.

In the present paper, the shock layer theory is applied to the analysis of the flow at the windward side of a wing situated in the hypersonic flow of an ideal gas. The three-dimensional flow past a plane wing with a curved leading edge is calculated by a small perturbation technique. Analytical expressions are derived for the gasdynamic functions and the shape of the shock wave. The influence of a rounded leading edge on the flow past a delta wing is studied. V.P.

A80-46846 # **Some aspects of the thermodynamics of duct jet flows (Nekotorye voprosy termodinamiki struinykh techenii v kanalakh).** V. L. Zimont. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 16-28. 7 refs. In Russian.

A thermodynamic analysis of jet engine operation is carried out for engines of the turbofan type. An ideal cycle is examined, using which the maximum attainable reactive force can be determined, along with the conditions under which the heat release from mixing jets will result in thrust augmentation. V.P.

A80-46847 # **Calculation of the flow in a supersonic air intake with allowance for the boundary layer on the fairings (Raschet techeniia v sverkhzvukovom vozdukhozabornike s uchetom pogranichnogo sloia na obtekaemykh poverkhnostiakh).** V. A. Vinogradov and V. V. Duganov. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 29-34. 15 refs. In Russian.

A straight-through method is proposed for calculating supersonic flows in plane and axisymmetric air intakes with allowance for the boundary layer. Calculations are carried out for an ideal gas, making corrections for the displacement thickness. Some numerical results for freestream Mach numbers in the range from 3 to 8 are given. V.P.

A80-46851 # **Flexural torsional vibrations of a wing (Ob izgibno-krutil'nykh kolebaniiakh kryla).** Ia. M. Parkhomovskii. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 60-74. 5 refs. In Russian.

The present analysis deals with the boundary value problem of the flexural torsional vibrations of a wing, using the beam approximation. Some general qualitative characteristics of the frequencies and mode shaped of vibrations are determined by means of a small parameter technique. V.P.

A80-46853 # **Aerodynamic characteristics of configurations consisting of half-cones and flat delta wings with supersonic leading edges (Aerodinamicheskie kharakteristiki konfiguratsii, sostoiashchikh iz polukonusov i ploskikh treugol'nykh kryl'ev so sverkhzvukovymy perednimi kromkami).** Iu. I. Lobanovskii. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 83-87. 6 refs. In Russian.

Numerical values are obtained for the lift coefficient, wave drag coefficient, and the L/D ratio of symmetric and asymmetric configurations consisting of flat delta wings with supersonic leading edges and half-cones mounted both on the suction and pressure sides of the wing. The values are tabulated for Mach numbers of 4, 6, and 8. The aerodynamic characteristics of such configurations are shown to satisfy certain similarity relations. The L/D ratio of a wing with a cone or half-cone on the suction side is higher than that of a wing with a half-cone on the pressure side. V.P.

A80-46855 # **Influence of nonequilibrium on the aerodynamic characteristics of some wing profiles (Vliianie neravnovesnosti na aerodinamicheskie kharakteristiki nekotorykh profilei).** V. L. Men'shikova. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 91-94. 6 refs. In Russian.

The paper deals with a qualitative analysis of the influence of nonequilibrium physicochemical processes in the region between the body and the shock wave on the pressure distribution over the surface of a hypersonic body. This influence is taken into consideration schematically, by using different specific heat ratios in different regions of the flow. V.P.

A80-46857 # **Correlation of thrust and discharge losses for chemically nonequilibrium flows in jet-engine nozzles (Korreliatsiia poter' tiagi i raskhoda pri khimicheski neravnovesnom techenii v soplakh VRD).** N. A. Dubov. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 100-108. In Russian.

Correlation formulas are derived which can be used for rapid and fairly accurate assessment of thrust losses in jet engines and changes in the discharge coefficient, resulting from nonequilibrium chemical recombination reactions in jet-engine nozzles. The formulas are obtained from a finite-difference solution of a system of Euler and relaxation equations in a quasi-one-dimensional approximation. V.P.

A80-46860 # **Study of the relaxation of the tightning force of bolted joints (Issledovanie relaksatsii usiliia zatiazhki boltovykh soedinenii).** I. I. Pospelov. *TsAGI, Uchenye Zapiski,* vol. 10, no. 5, 1979, p. 120-127. 6 refs. In Russian.

An engineering method is proposed for calculating the relaxation of the tight-fit of bolted joints. For illustration, the method is applied to the determination of the tight-fit relaxation of supersonic-transport bolted joints. V.P.

A80-46861 # **Limiting values of the lift coefficient of lifting bodies with a flat surface at supersonic speeds (Predel'nye znacheniia koeffitsienta pod'emnoi sily nesushchikh tel s ploskoi nizhnei poverkhnost'iu pri sverkhzvukovykh skorostiakh).** V. V. Keldysh. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 1-10. 14 refs. In Russian.

From an analysis of a wealth of aerodynamic data, it is shown that at Mach numbers greater than 3, the aerodynamic characteristics of delta-wing and half-cone delta wing configurations with a flat or almost flat lower surface are independent of the shape of the upper surface and are not influenced by any further increase in Mach number. The maximal value of the lift coefficient is attained at angles of attack close to 50 degrees, and decreases rapidly with increasing sweepback of the leading edges. V.P.

A80-46862 # **Calculation of the interaction between an exhaust jet and a high-lift wing (K raschetu vzaimodeistviia strui dvigatelia s mekhanizirovannym krylom).** V. S. Savin. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 11-18. 5 refs. In Russian.

A method is proposed for calculating the aerodynamic characteristics of a transport aircraft with allowance for the interaction between the exhaust jet of a suspended turbojet engine and an externally-blown jet flap. In this method, the jet is treated as an incompressible fluid flow with a constant velocity profile across the jet, the flow velocity being defined by the engine's thrust coefficient. V.P.

A80-46869 # **Scatter of fatigue-life data for elements of full-scale light-aircraft wings under steady loads (Rasseianie dolgovechnosti elementov naturnykh kryl'ev legkikh samoletov pri statsionarnom nagruzhenii).** A. F. Selikhov, V. Ia. Senik, and I. E. Ushakov. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 74-80. 6 refs. In Russian.

A method is proposed for determining statistical fatigue-life data for elements of a structure from constant-amplitude fatigue tests of the structure itself. The scatter of fatigue-life data is studied by the method of maximum likelihood. Scatter of fatigue-life data is generalized, using the results of full-scale tests with a variety of light aircraft. The obtained numerical characteristics of fatigue-life scatter are compared with previous results. V.P.

A80-46870 # **The weight-minimization problem for a forward-swept wing with constraints on the rate of wing divergence (Zadacha minimizatsii vesa kryla s obratnoi strelovidnost'iu pri ogranichenii skorosti divergentsii).** A. P. Seiranian. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 81-89. 14 refs. In Russian.

A solution is obtained to the problem of minimizing the weight of a forward-swept wing at a fixed critical rate of wing divergence. The solution is useful in designing aircraft with a wing of variable geometry. V.P.

A80-46871 # **Investigation of the influence of the parameters of a wing/engine combination on the critical flutter speed (Issledovanie vliianiia parametrov komponovki kryla s dvigateliami na velichinu kriticheskoi skorosti flattera).** N. G. Dulina. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 90-98. In Russian.

In the present paper, the critical flutter speed of a large aspect ratio wing is studied as a function of the location of the engines on the wing. For parameteric studies, an approximate method based on the Rayleigh principle is proposed. The rational arrangement of the engine with respect to the principal axes of the wing is determined on the basis of a simplified model, where the mass and stiffness characteristics of the wing are determined for a selected cross section. V.P.

A80-46872 # **Experience in correcting dynamic designs on the basis of resonance test data (Opyt korrektirovaniia raschetnoi dinamicheskoi skhemy po rezul'tatam rezonansnykh ispytanii).** O. A. Kuznetsov and V. I. Smyslov. *TsAGI, Ucheny Zapiski,* vol. 10, no. 6, 1979, p. 99-112. 8 refs. In Russian.

The paper deals with some results of applying resonance test data obtained with modern test facilities to the correction of elastic idealized structural models. The test data involve flutter and damping phenomena, eigenfrequencies, mode shapes of vibration, stress distributions, etc. under conditions of transient resonance vibrations. For illustration, the experimental and analytical techniques proposed are applied to the correction of the dynamic design of an aircraft with a large-aspect-ratio wing. V.P.

A80-46873 # **Application of spline approximations to the calculation of wall pressures in three-dimensional supersonic nozzles (Ispol'zovanie splain-approksimatsii dlia rascheta davleniia po stenkam sverkhzvukovykh prostranstvennykh sopl).** V. M. Borisov, M. P. Levin, and I. E. Mikhailov. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 118-121. In Russian.

The paper deals with the numerical calculation of the pressure distribution over the walls of three-dimensional supersonic nozzles and diffusors. In the procedure proposed, the derivatives in the meridian plane are approximates by derivatives of splines of various order. V.P.

A80-46877 # **Influence of optimizing the strength of a structure on the mode shapes and frequencies of the normal modes (Vliianie optimizatsii konstruktsii po usloviiam prochnosti na formy i chastoty ee sobstvennykh kolebanii).** M. N. Muratovskaia and V. N. Semenov. *TsAGI, Uchenye Zapiski,* vol. 10, no. 6, 1979, p. 144-146. In Russian.

The paper deals with the application of the finite element method to the development of programs for solving optimization problems for structures and problems of static and dynamic stability for flight vehicles. It is shown that optimization of a structure with respect to stability leads to an increase in effective stiffness of the structure and, as a consequence, to an increase, in excess of 10%, in the eigenfrequencies of its elastic vibrations. V.P.

A80-47169 # **Determination of the residual life of gas turbine engines by analyzing the safety factors of the most heavily loaded elements (Opredelenie ostatochnogo resursa gazoturbinnykh dvigatelei na osnove analiza zapasov prochnosti naibolee nagruzhennykh elementov).** A. K. Ianko. *Promyshlennaia Teplotekhnika,* vol. 2, no. 4, 1980, p. 89-93. In Russian.

The proposed method for determining the residual operational life of an engine is based on the hypothesis of linear damage accumulation in the process of long-term static loading under various operation conditions. It is shown how statistical data can be used to obtain a probability estimate of the residual life. V.L.

A80-47177 # **Range of applicability and energetic characteristics of small-scale high-pressure-gradient birotational turbines (Oblasti vozmozhnogo primeneniia i energeticheskie kharakteristiki vysokoperepadnykh malorazmernykh birotativnykh turbin).** I. P. Goldaev, V. V. Il'inskii, and E. A. Skvorchevskii. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 10-14. In Russian.

The energetic characteristics of two-shaft turbine with counter-rotating wheels are analyzed. It is shown that the efficiency of a two-shaft turbine with different rotational frequencies of the wheels is superior to that of a high-pressure turbine running on a hot gas. V.P.

A80-47178 # **Experimental facility for studying the thermal effect of supersonic gas jets on targets (Eksperimental'naia ustanovka dlia issledovaniia teplovogo vozdeistviia sverkhzvukovykh gazovykh strui na pregrady).** I. P. Goldaev and V. V. Spesivtsev. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 14-19. In Russian.

The design and principle of a facility developed to study the thermal effect of impinging supersonic jets are described. The jet generator, feed system, measurement system, and other elements of the facility are discussed, and some data on the heat flux distribution on flat surfaces are examined. V.P.

A80-47179 # **Calorimetric sensor for measuring temperature fields generated by intense heat sources (Kalorimetricheskii datchik dlia izmereniia teplovykh polei pri vysokotemperaturnom vozdeistvii).** V. V. Spesivtsev. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 19-25. In Russian.

The device described in the present paper will measure the heat-transfer parameter field for nonuniform heating. Some of the principal systems and elements of the device are illustrated and discussed. Data on the distribution of heat fluxes on flat surfaces at the point of impingement of a supersonic high-temperature jet are examined. V.P.

A80-47180 # **Analysis of experimental indicators of the hydrodynamic force at a needle-type throttle (Analiz eksperimental'nykh pokazatelei gidrodinamicheskoi sily na igloobraznom drosseliruiushchem elemente).** V. P. Gus'kov. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 25-32. 6 refs. In Russian.

The paper deals with two methodological approaches to the experimental determination of the hydrodynamic force exerted by a liquid (fuel) on the conical surface of a needle-type regulator of feed system. One approach is based on integrating the pressure distribution curves over the conical surface. The other approach is the direct measurement of the physical load. V.P.

A80-47181 # **Influence of swirl chamber dimensions on the jet angle of an air nozzle (Vliianie razmerov kamery zakruchivaniia na ugol fakela vozdushnoi forsunki).** V. V. Smantser. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 33-35. In Russian.

A80-47183 # **Organizing multistage energy conversion systems (Ob organizatsii mnogokaskadnykh sistem preobrazovaniia energii).** I. L. Varshavskii, A. S. Kutsenko, and I. V. Strelkov. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 37-41. In Russian.

The paper deals with some aspects of designing multistage energy converters with external energy supply. It is shown that the problem of optimizing a multistage converter can be reduced to the classical problem of multistep optimal decision making. Some special cases are examined. V.P.

A80-47184 # **Optimal designing of shells and plates with discrete stiffeners (Optimal'noe proektirovanie obolochek i plastin s diskretnymi rebrami zhestkosti).** V. G. Korbach and Iu. P. Petrov. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 42-47. 10 refs. In Russian.

A solution is obtained to the problem of designing optimal shells and plates with discretely spaced unidirectional stiffeners. The method employed is based on the use of finite-difference schemes in conjunction with difference-differential methods and methods of optimal control theory for solving systems of ordinary linear differential equations in the presence of constraints on the geometry of the structure and its behavior in elastic deformation. V.P.

A80-47186 # **Determination of aircraft take-off weight in the preliminary design stage (Opredelenie vzletnogo vesa samoleta pri predvaritel'nom proektirovanii).** A. A. Kobylianskii and V. N. Nosik. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 55-60. 5 refs. In Russian.

A simple computer-aided method is proposed for calculating the minimum take-off weight for a given take-off run, taking fuel economy and flight safety into consideration. The method is particularly well suited for use in the preliminary design stage. V.P.

A80-47187 # **Construction of cyclic and ruled surfaces by the method of generalized inversion (Konstruirovanie tsiklicheskikh i lineichatykh poverkhnostei metodom obobshchennoi inversii).** A. V. Miroshnichenko. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 60-66. In Russian.

The paper deals with a new method of constructing complex cyclic and ruled surfaces of the type used in the aircraft and shipbuilding industry. The method is based on the use of transformations which may be treated as generalized inversion. The method makes it possible to construct cyclic and ruled surfaces on the basis of simple surfaces of revolution. V.P.

A80-47190 # **Selection of tube diameters for aircraft deicing systems (O vybore diametrov truboprovodov v sistemakh protivoobledeneniia letatel'nykh apparatov).** B. D. Ialovkin. *Samoletostroenie - Tekhnika Vozdushnogo Flota,* no. 44, 1978, p. 75-79. 5 refs. In Russian.

A method is proposed for calculating tube diameters for aircraft deicing systems. The problem is formulated as a problem of mathematical programming, amenable to solution by the method of penalty functions. V.P.

A80-47200 **Fabrication techniques for advanced reinforced plastics; Proceedings of the Symposium, University of Salford, Salford, Lancs., England, April 22, 23, 1980.** Symposium sponsored by James Carr and Sons, Courtaulds, Ltd., Fothergill and Harvey, Ltd., et al. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1980. 122 p.

Papers contained in this work describe details of novel fabrication procedures used with complex reinforced composite elements of structures and machinery. Topics discussed include aspects of the autoclave process, compression molding of aircraft engine components featuring thermal stability, use of aligned discontinuous fiber prepreg, vacuum molding, resin injection methods, precision filament winding, pultrusion methods, tape laying, film stacking, wet layup of carbon fiber fabric, and effects of processing parameters on fiber orientation. T.M.

A80-47202 **The compression moulding of composite aero engine components with elevated thermal stability.** F. C. Johnson (Rolls-Royce, Ltd., Non-Metallics Laboratory, Derby, England). In: Fabrication techniques for advanced reinforced plastics; Proceedings of the Symposium, Salford, Lancs., England, April 22, 23, 1980. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1980, p. 10-18.

An historical background of the RB162 booster engine is outlined, and the development of glass reinforced composite components with improved thermal stability is described. The processing modifications required in the utilisation of Kerimid 601 bismaleimide resin for matched die moulding of small complex shapes are discussed. The advantages, complexities, and problems associated with the new materials are shown, and a comparison of behaviour under stress of epoxy-novolak and polyimide rotor blades is made. (Author)

A80-47206 **A resin injection technique for the fabrication of aero-engine composite components.** W. R. Jones and J. W. Johnson (Rolls-Royce, Ltd., Plastics and Composite Materials Laboratory, Derby, England). In: Fabrication techniques for advanced reinforced plastics; Proceedings of the Symposium, Salford, Lancs., England, April 22, 23, 1980. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1980, p. 40-47.

The paper describes a method for the manufacture of high quality composite aero-engine components, free from voids and having a high degree of dimensional reproducibility. The technique uses a porous fibre preform held in the component shape by the use of a thermoplastic binder. The preform is then infiltrated with epoxy resin in a closed die using a vacuum assisted high pressure injection method. It is possible to include inserts or third dimension reinforcement in components, and reference is made to the production of a carbon fiber fan blade and a grp nose spinner. (Author)

A80-47211 **An investigation into the feasibility of producing aircraft structural components using wet lay-up of carbon fibre fabric.** E. J. Phillips and G. Thompson (British Aerospace, Kingston-Brough Div., Brough, Humberside, England). In: Fabrication techniques for advanced reinforced plastics; Proceedings of the Symposium, Salford, Lancs., England, April 22, 23, 1980. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1980, p. 108-117.

A80-47323 # **Future fighter technologies.** W. B. Herbst (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *Journal of Aircraft,* vol. 17, Aug. 1980, p. 561-566. 12 refs.

The paper describes fighter aircraft design based upon current advances in aerodynamics, control technology of delta wings, and on 'supermaneuverability' (a combination of poststall and side-slipping maneuvers). This design is expected to satisfy diverging requirements for high-performance, low-speed maneuverability, and short field performance against a superior number of hostile aircraft at lower cost than by conventional fighters. The concept was tested by extensive wind tunnel experiments, and in manned and model air combat simulations. A.T.

A80-47324 * # **Jet decay rate effects on hover jet-induced loads.** J. M. Kuhlman and R. W. Warcup (Old Dominion University, Norfolk, Va.). *Journal of Aircraft,* vol. 17, Aug. 1980, p. 605-607. 13 refs. Contract No. NAS1-14193-40.

The paper explains the mechanisms for observed jet decay rate effects on jet-induced loads on a flat plate for cross-flow and hover configurations. Examples are presented for the influence of the decay rate on integrated loads on a flat plate induced by the jet issuing at a right angle from the plate into still air; knowledge of these jet-induced loadings is of particular importance for VTOL aircraft design because they produce an effective loss in the lift force available in hover. The apparent inconsistency between existing lift loss vs jet decay rate trends is explained in light of the different mechanism which determine the jet mixing and trajectory, i.e., entrainment, blockage, and the vortex pair associated with a jet in crossflow. A.T.

A80-47325 # **Comment on 'Calculation of rotor impedance for articulated-rotor helicopters in forward flight'.** D. A. Peters (Washington University, St. Louis, Mo.). *Journal of Aircraft,* vol. 17, Aug. 1980, p. 607; Reply, p. 607, 608.

A80-47355 **Some applications of the methods of failure mechanics in analyzing the strength and service life of aircraft structures.** G. Iu. Bengus. *(Fiziko-Khimicheskaia Mekhanika Materialov,* vol. 15, Nov.-Dec. 1979, p. 9-17.) *Soviet Materials Science,* vol. 15, no. 6, May 1980, p. 557-563. 5 refs. Translation.

Problems encountered in the application of the methods of failure mechanics to the analysis of the service life of aircraft structures are discussed with particular reference to the concept of increased life and allowable damage. The concept is illustrated by an example involving an aircraft wing. Some of the problems discussed include: the development of a method for evaluating the sensitivity of crack growth rate to nonsteady loading for the purpose of comparing the properties of alloys, analytical description and calculation of the growth of a center crack in static failure of flat samples, and the development of effective algorithms and computer programs for calculating by the finite element method stress intensity factors and the J-integral in reinforced panels of specific shapes. V.L.

STAR ENTRIES

N80-28296*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A COMPREHENSIVE ANALYTICAL MODEL OF ROTORCRAFT AERODYNAMICS AND DYNAMICS. PART 1: ANALYSIS DEVELOPMENT
Wayne Johnson Jun. 1980 442 p refs Prepared in cooperation with Army Aviation Research and Development Command, Moffett Field, Calif. 2 Vol.
(NASA-TM-81182; AVRADCOM-TR-80-A-5-Pt-1; A-8100) Avail: NTIS HC A19/MF A01 CSCL 01B

Structural, inertia, and aerodynamic models were combined to form a comprehensive model of rotor aerodynamics and dynamics that is applicable to a wide range of problems and a wide class of vehicles. A digital computer program is used to calculate rotor performance, loads, and noise; helicopter vibration and gust response; flight dynamics and handling qualities; and system aeroelastic stability. The analysis is intended for use in the design, testing, and evaluation of rotors and rotorcraft, and to be a basis for further development of rotary wing theories.
A.R.H.

N80-28297*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A COMPREHENSIVE ANALYTICAL MODEL OF ROTORCRAFT AERODYNAMICS AND DYNAMICS. PART 2: USER'S MANUAL
Wayne Johnson Jul. 1980 97 p Prepared in cooperation with Army Aviation Research and Development Command, Moffett Field, Calif. 2 Vol.
(NASA-TM-81183; AVRADCOM-TR-80-A-6-Pt-2; A-8101) Avail: NTIS HC A05/MF A01 CSCL 01B

The use of a computer program for a comprehensive analytical model of rotorcraft aerodynamics and dynamics is described. The program calculates the loads and motion of helicopter rotors and airframe. First the trim solution is obtained, then the flutter, flight dynamics, and/or transient behavior can be calculated. Either a new job can be initiated or further calculations can be performed for an old job.
E.D.K.

N80-28298*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A COMPREHENSIVE ANALYTICAL MODEL OF ROTORCRAFT AERODYNAMICS AND DYNAMICS. PART 3: PROGRAM MANUAL
Wayne Johnson Jun. 1980 155 p Prepared in cooperation with Army Aviation Research and Development Command, St. Louis, Mo.
(NASA-TM-81184; AVRADCOM-TR-80-A-7; A-8102) Avail: NTIS HC A08/MF A01 CSCL 01B

The computer program for a comprehensive analytical model of rotorcraft aerodynamics and dynamics is described. This analysis is designed to calculate rotor performance, loads, and noise; the helicopter vibration and gust response; the flight dynamics and handling qualities; and the system aeroelastic stability. The analysis is a combination of structural, inertial, and aerodynamic models that is applicable to a wide range of problems and a wide class of vehicles. The analysis is intended for use in the design, testing, and evaluation of rotors and rotorcraft and to be a basis for further development of rotary wing theories.
Author

N80-28300* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
SYSTEM FOR USE IN CONDUCTING WAKE INVESTIGATION FOR A WING IN FLIGHT Patent
Paul F. Bikle, inventors (to NASA) and Lawrence C. Montoya Issued 15 Jul. 1980 9 p Filed 28 Feb. 1979 Supersedes N79-17797 (17 - 09, p 1069)
(NASA-Case-FRC-11024-1; US-Patent-4,212,199; US-Patent-Appl-SN-015983; US-Patent-Class-73-861.66; US-Patent-Class-73-180; US-Patent-Class-73-182; US-Patent-Class-73-861.65) Avail: US Patent and Trademark Office CSCL 01A

A system supported by a wing in flight is described which has a reference total pressure port in spaced relation with a wake as the wake is generated by the wing, a reference static pressure port supported in spaced relation with the wake, and a probe adapted to be displaced along an accurate path through the wake including a total pressure port and static pressure ports. A differential pressure transducer and a pressure switching device are interposed between the ports and the transducer is provided for selectively connecting pairs of the ports to the transducer in opposed relation, whereby a single transducer is utilized to obtain differential pressure measurement for the wake with enhanced accuracy.
Official Gazette of the U.S. Patent and Trademark Office

N80-28303*# De Havilland Aircraft Co. Ltd., Downsview (Ontario).
PHASE 1 WIND TUNNEL TESTS OF THE J-97 POWERED, EXTERNAL AUGMENTOR V/STOL MODEL
D. B. Garland Jul. 1980 101 p refs
(Contract NASw-2797)
(NASA-CR-152255; DHC-DND-79-4) Avail: NTIS HC A06/MF A01 CSCL 01A

Test results are presented for a large scale, external augmentor V/STOL model in a 40 ft by 80 ft wind tunnel. The model was powered by a GE J97 engine and featured longitudinal ejectors alongside and external to the fuselage together with an augmentor flap on the low aspect ratio, double-delta wing. A static thrust augmentation ratio of 1.60 was measured for the fuselage augmentor at a nozzle pressure ratio of 3.0 and a nozzle exhaust gas temperature of 700 C. At forward speed the model showed a strong positive lift interference due to the augmentor flap, and a marked absence of negative lift interference due to the fuselage augmentor jet system. The nose-up moment of the fuselage augmentor inlet flow was approximately cancelled by a 60 deg deflection of the augmentor flap. An assessment of the thrust and drag components to allow the prediction of transition performance of aircraft designs based on the present conceptual model was made. Lateral tests showed strong but well ordered effects of power.
L.F.M.

N80-28304*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
WATER-TUNNEL AND ANALYTICAL INVESTIGATION OF THE EFFECT OF STRAKE DESIGN VARIABLES ON STRAKE VORTEX BREAKDOWN CHARACTERISTICS
Neal T. Frink and John E. Lamar Aug. 1980 92 p refs
(NASA-TP-1676; L-13254) Avail: NTIS HC A05/MF A01 CSCL 01A

A systematic water-tunnel study was made to determine the vortex breakdown characteristics of 43 strakes. The strakes were mounted on a 1/2-scale model of a Langley Research Center general research fighter fuselage model with a 44deg leading-edge-sweep trapezoidal wing. The analytically designed strake shapes provided examples of the effects of the primary design parameters (size, span, and slenderness) on vortex breakdown characteristics. These effects were analyzed in relation to the respective strake leading-edge suction distributions. Included were examples of the effects of detailed strake planform shaping. It was concluded that, consistent with the design criterion, those strakes with leading-edge suction distributions which increase more rapidly near, and have a higher value at, the spanwise tip of the strake produce a more stable vortex.
Author

N80-28307*# Mississippi State Univ., Mississippi State.
AN APPROXIMATE FACTORIZATION SOLUTION OF THE NAVIER-STOKES EQUATIONS FOR TRANSONIC FLOW USING BODY-FITTED COORDINATES WITH APPLICATION TO NACA 64A010 AIRFOILS

G. Kyle Copper Aug. 1980 120 p refs
(Grant NGR-25-001-055)
(NASA-CR-163376) Avail: NTIS HC A06/MF A01 CSCL 01A

The implementation of the approximate factorization algorithm and its ability to efficiently and accurately describe transonic flow about an NACA 64A010 airfoil section is examined. The approximate factorization algorithm is developed from the nondimensional, conservative, vectorized Navier-Stokes equations expressed in curvilinear coordinates. Equations of state and transport coefficient relations appropriate to atmospheric air are appended to close the system of partial differential equations. An algebraic turbulence model is also incorporated into the equation set. This algorithm was verified by investigating the flow about an NACA 64A010 airfoil at 0, 2, and 3.5 deg angle of attack for free-stream conditions of 2,000,000 Reynolds number and 0.8 Mach number. Overall results were in good qualitative agreement with wind tunnel data sets. However, while nondimensional times of six were attained, numerical difficulties prevented any case from reaching a true steady state. M.G.

N80-28308*# Analytical Methods, Inc., Bellevue, Wash.
AN ANALYSIS METHOD FOR MULTI-COMPONENT AIRFOILS IN SEPARATED FLOW
B. M. Rao, F. A. Duorak, and B. Maskew Aug. 1980 43 p refs
(Contract NAS1-25729)
(NASA-CR-159300) Avail: NTIS HC A03/MF A01 CSCL 01A

The multi-component airfoil program (Langley-MCARF) for attached flow is modified to accept the free vortex sheet separation-flow model program (Analytical Methods, Inc.-CLMAX). The viscous effects are incorporated into the calculation by representing the boundary layer displacement thickness with an appropriate source distribution. The separation flow model incorporated into MCARF was applied to single component airfoils. Calculated pressure distributions for angles of attack up to the stall are in close agreement with experimental measurements. Even at higher angles of attack beyond the stall, correct trends of separation, decrease in lift coefficients, and increase in pitching moment coefficients are predicted. Author

N80-28316# Lockheed-Georgia Co., Marietta.
ACQUISITION AND APPLICATION OF TRANSONIC WING AND FAR-FIELD TEST DATA FOR THREE-DIMENSIONAL COMPUTATIONAL METHOD EVALUATION, VOLUME 1 Final Report, May 1978 - Aug. 1979
B. L. Hinson and K. P. Burdges Mar. 1980 217 p refs
(Contract F49620-78-C-0068; AF Proj. 2307)
(AD-A085258; LG80ER0012-Vol-1; AFOSR-80-0421TR) Avail: NTIS HC A10/MF A01 CSCL 20/4

A comprehensive program to acquire high Reynolds number transonic experimental data on three advanced technology wings of aspect ratio from 2.8 to 8.0, specifically for evaluation of three dimensional computational methods, was accomplished. The wings were tested over a wide range of conditions isolated wings and in the presence of a simple fuselage in high, mid, and low wing configurations on a unique test apparatus in the Lockheed-Georgia compressible flow wind tunnel. The unique test apparatus included provisions for removal of the wind tunnel boundary layer and measurements of far-field pressures for evaluation of wind tunnel wall interference. A unique technique for evaluation of wind tunnel wall interference was developed and applied to the data. Selected three dimensional transonic computational methods were compared with the test data. A Full potential code, FLO-22, was found to give excellent agreement with experiment for all three wings, while a small disturbance solution provided acceptable agreement only for the high aspect ratio wing. GRA

N80-28319# Rutgers - The State Univ., New Brunswick, N. J. Dept. of Mechanical, Industrial and Aerospace Engineering.
CALCULATION OF HIGH SPEED INLET FLOWS USING THE NAVIER-STOKES EQUATIONS. VOLUME 2: USER'S AND PROGRAMMER'S GUIDE Final Report, Apr. 1978 - Sep. 1979
Doyle D. Knight Wright-Patterson AFB, Ohio AFFDL Feb. 1980 138 p refs
(Contract F33615-78-C-3008; AF Proj. 2307)
(AD-A084790; AFFDL-TR-79-3138-Vol-2) Avail: NTIS HC A07/MF A01 CSCL 21/5

A series of four computer programs used to compute the flowfield within a two dimensional, mixed compression, high speed, aircraft inlet are documented. a brief description is presented of the physical problem and the mathematical model. The numerical methods are discussed and the limitations of the approach are indicated. A brief summary of the four programs is presented together with the general sequence of application. The coordinate system programs are discussed in detail with emphasis on the pertinent criteria for successful implementation. The details of the Navier-Stokes code employed for solution of the inlet flowfield are presented. In addition, the details of a simple utility program used to interpolate flow filed data are discussed. E.D.K.

N80-28324# Army Aviation Engineering Flight Activity, Edwards AFB Calif.
MICROPHYSICAL PROPERTIES OF ARTIFICIAL AND NATURAL CLOUDS AND THEIR EFFECTS ON UH-1H HELICOPTER ICING Final Report, Jan. - Mar. 1979
Grady W. Wilson and Ralph Woratschek Aug. 1979 102 p refs
(AD-A084633; USAAEFA-78-21-2) Avail: NTIS HC A06/MF A01 CSCL 01/3

Natural and artificial icing tests were conducted from 22 January to 22 February 1979 in the vicinity of St. Paul, MN with follow-on natural tests conducted from 26 February to 21 March 1979 in the vicinity of Syracuse, NY. A total of 6.7 hours were flown in the artificial environment and 7.8 hours in the natural environment. Artificial conditions were tested at liquid water content (LWC) range of 0.25 to 0.90 gm/m to the 3rd power with a temperature range of -10 to -20 C. Natural conditions were encountered at LWC range of 0.06 to 0.23 gm/m to the 3rd power and a temperature range of -2.5 to -22 C. Tests were conducted to determine the feasibility of operational deployment of a partial ice protection system consisting of electrothermally heated windshields, a sensitive outside air temperature (OAT) system, a LWC indicator and associated electrical changes. The test aircraft was a JUH-1H helicopter equipped with electrothermally decided blades as a safety device and laser nephelometers which were used to quantify the microphysical properties of the test environment. It was determined that the artificial environment (Helicopter Icing Spray System (HISS)) was not an adequate simulation in its present configuration. This was due in part to the large droplet size, heterogeneous characteristic of the plume and concentration of large droplets in the lower portion of the plume. It was also determined that the partial ice protection system did not increase the operational capability of the UH-1H helicopter and that LWC is not an adequate indication of icing severity. GRA

N80-28326# Office of Technology Assessment, Washington, D. C.
IMPACT OF ADVANCED AIR TRANSPORT TECHNOLOGY. PART 1: ADVANCED HIGH-SPEED AIRCRAFT
William E. Howard Apr. 1980 115 p refs
(OTA-T-112-Pt-1) Avail: NTIS HC A06/MF A01

The economic, environmental, energy, societal and safety impacts of advances in high-speed aircraft technology were examined to determine the potential benefits of advanced supersonic transport aircraft and the justification for Federal funding to support development of this technology. Results indicate that: the long term prospects for advanced supersonic transports are significant and real; the uncertainties, specifically, fuel price and availability, noise, and market size, are also significant and real, and the potential threat from foreign competitors appears tempered by the same research uncertainties. Other significant results are reported. DOE

N80-28327# Societe Nationale Industrielle Aerospatiale, Toulouse (France). Direction Etudes.

AIRCRAFT SAFETY [SECURITE DU VEHICLE AERIEN]
P. Toulouse Paris 13 Apr. 1979 21 p ref In FRENCH; ENGLISH summary
(SNIAS-792-111-105) Avail: NTIS HC A02/MF A01

The way in which air transportation risks are identified from both experience and analysis is described. The probabilistic approach used to decrease the likelihood of occurrence of accidents and to minimize their consequences is also described. Author (ESA)

N80-28328# Societe Nationale Industrielle Aerospatiale, Paris (France).
SUPERSONIC TRANSPORT: THE PAST, PRESENT AND THE FUTURE [LE TRANSPORT SUPERSONIQUE: LE PASSE, LE PRESENT ET L'AVENIR]
22 Apr. 1979 18 p In FRENCH
(SNIAS-792-111-107) Avail: NTIS HC A02/MF A01

The history of the Concorde project is presented. Attention is drawn to certain miscalculations in estimating the time necessary for its development and realization. Attention is also drawn to differences between financial, economic and social conditions prevailing at the time when it was conceived and today, notably concerning the potential market (initially the sale of several hundred models was envisaged) and environmental and ecological pressures. Author (ESA)

N80-28330*# Analytical Mechanics Associates, Inc., Mountain View, Calif.
ANALYTICAL METHODOLOGY FOR DETERMINATION OF HELICOPTER IFR PRECISION APPROACH REQUIREMENTS
Anil V. Phatak Jul. 1980 124 p refs
(Contract NAS2-10291)
(NASA-CR-152367) Avail: NTIS HC A06/MF A01 CSCL 17G

A systematic analytical approach to the determination of helicopter IFR precision approach requirements is formulated. The approach is based upon the hypothesis that pilot acceptance level or opinion rating of a given system is inversely related to the degree of pilot involvement in the control task. A nonlinear simulation of the helicopter approach to landing task incorporating appropriate models for UH-1H aircraft, the environmental disturbances and the human pilot was developed as a tool for evaluating the pilot acceptance hypothesis. The simulated pilot model is generic in nature and includes analytical representation of the human information acquisition, processing, and control strategies. Simulation analyses in the flight director mode indicate that the pilot model used is reasonable. Results of the simulation are used to identify candidate pilot workload metrics and to test the well known performance-work-load relationship. A pilot acceptance analytical methodology is formulated as a basis for further investigation, development and validation. Author

N80-28331# National Aviation Facilities Experimental Center, Atlantic City, N. J.
FLIGHT EVALUATION OF A RADAR CURSOR TECHNIQUE AS AN AID TO AIRBORNE RADAR APPROACHES Interim Report, Jul. - Aug. 1979
J. Perez Mar. 1980 38 p
(AD-A084015; FAA-NA-80-8; FAA-RD-80-18) Avail: NTIS HC A03/MF A01 CSCL 17/9

This report presents preliminary results of a flight test evaluation of a radar cursor technique to be used as an aid in acquiring and tracking the desired ground track during airborne radar approaches. The test was performed using a Sikorsky CH-53A helicopter on loan from NASA and based at NAFEC. The airborne radar system used was a BENDIX RDR-1400A modified to electronically produce a radar cursor display of course error. Airborne radar approaches were made to an offshore and an airport test environment located within a 60 nautical mile radius of NAFEC. Systems Control, Inc. (SCI), provided contractor services in the areas of test planning, data reduction, and final report preparation. The specific purpose of the test was to evaluate the practical utility of the radar cursor as an aid to performing airborne radar approaches. The preliminary conclusion of this test was that the use of the radar cursor improved course acquisition and ground tracking significantly with pilotage errors and total system cross-track errors reduced by one-half or better. The radar cursor technique showed potential in reducing airspace requirements for airborne radar approaches. SCI is presently completing data reduction and analysis and will publish a final report in the near future. GRA

N80-28332# Naval Electronic Systems Engineering Activity, St. Inigoes, Md.
CERTIFICATION TEST PROCEDURES FOR AIRCRAFT APPROACH CONTROL, AN/SPN-41, REVISION
1 May 1979 66 p
(AD-A084385; NESEA-79-30-22-Rev.; NESEA-022-106A-Rev) Avail: NTIS HC A04/MF A01 CSCL 17/9

Aircraft Approach Control AN/SPN-41, composed of shipboard and airborne equipments, can be used as an independent landing aid or as a Mode 1 monitor on AN/SPN-42A equipped carriers. In order to satisfactorily accomplish this monitoring, each piece of equipment must operate within allowable tolerances. These tests are designed to provide the criteria for initial and periodic checks of the system to ensure operation within acceptable limits. There are three categories of certification tests. Category 1 tests are the basic equipment tests. Category 2 tests are pierside flights to check the system alignment and correlation of the AN/SPN-41 with the AN/SPN-42A and the Fresnel Lens Optical Landing System (FLOLS). Category 3 tests are the at-sea flight tests using aircraft equipped to record data. GRA

N80-28334# Lincoln Lab., Mass. Inst. of Tech., Lexington.
GENERATION OF THE DISCRETE ADDRESS BEACON SYSTEM (DABS) NETWORK COVERAGE MAP Final Report
David Reiner 20 Mar. 1980 61 p refs
(Contracts F19628-78-C-0002; DOT-FA72WAI-261)
(AD-A085129; FAA-RD-80-39) Avail: NTIS HC A04/MF A01 CSCL 17/7

This paper describes the technique of designing the network management coverage map files necessary to coordinate a network of DABS sensors. First, the concept of the DABS network is defined, and the functions of Network Management are briefly described, as they relate to the coverage map. Then, the rationale for the coverage map is given together with definitions of the map structure and the information required in the file. Implementation of these definitions is illustrated in terms of a specific example: a network of four DABS sensors in the Washington, D.C. area. As configured, each of the sensors provides service to only one of four ATC facilities (three TRACONs and one ARTCC). The resulting map generation process illustrates not only the general principles but also the significant effects of ATC control area geometry and ATARS requirements. Finally, the procedure required for automated map generation is defined. This procedure assumes the use of an interactive computer display terminal and is applicable to any sensor network and ATC facility configuration. GRA

N80-28335# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DISCRETE ADDRESS BEACON SYSTEM (DABS) INSTALLATION AND SITING CRITERIA Final Report
R. G. Sandholm 29 Jan. 1980 36 p refs
(Contract DOT-FA72WAI-261; FAA Proj. 052-241-04)
(AD-A085178; FAA-RD-80-40) Avail: NTIS HC A03/MF A01 CSCL 17/7

This paper provides information on site-associated phenomena that affect the proper operation of a DABS sensor and therefore warrant serious consideration when siting a sensor. The DABS-related discussion is intended to be a supplement to the ATCRBS siting criteria presented in the FAA Primary/Secondary Terminal Radar Siting Handbook. The paper discusses siting criteria as they relate to the DABS sensor antenna system, as opposed to the ATCRBS hogtrough antenna, and importantly, addresses those characteristics of the surrounding environment that are crucial to proper DABS/ATARS surveillance. GRA

N80-28336# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DISCRETE ADDRESS BEACON SYSTEM (DABS) FUNCTIONAL DESCRIPTION Final Report

V. A. Orlando and P. R. Drouilhet Apr. 1980 105 p refs
(Contract DOT-FA72WAI-261; FAA Proj. 052-241-04)
(AD-A085169; ATC-42A) Avail: NTIS HC A06/MF A01 CSCL 17/7

This document provides a functional description of the Discrete Address Beacon System (DABS), a combined secondary surveillance radar (beacon) and ground-air-ground data link system capable of providing the aircraft surveillance and communications necessary to support ATC automation in future traffic environments. DABS is capable of common-channel interoperation with the current ATC beacon system, and may be implemented at low user cost over an extended ATCRBS-to-DABS transition period. In supporting ATC automation, DABS will provide the surveillance and communication performance required by the Automatic Traffic Advisory and Resolution Service (ATARS), the reliable communications needed to support data link services, and the capability of operating with a terminal or enroute, radar digitizer-equipped, ATC surveillance radar. GRA

N80-28337# Mitre Corp., McLean, Va. Metrek Div.
DISCRETE ADDRESS BEACON SYSTEM/AUTOMATED TRAFFIC ADVISORY AND RESOLUTION SERVICE/AIR TRAFFIC CONTROL OPERATIONAL SYSTEM DESCRIPTION Final Report
J. E. Dieudonne and R. W. Lautenschlager Apr. 1980 121 p refs
(Contract DOT-FA80WA-4370)
(AD-A085180; MTR-79W00436; FAA-RD-80-42) Avail: NTIS HC A06/MF A01 CSCL 17/7

This document describes the Discrete Address Beacon System (DABS) sensor and the collocated Automatic Traffic Advisory and Resolution Service (ATARS) function relative to their interactions with the Air Traffic Control (ATC) facilities. A general description of the Terminal and En Route ATC facility modifications for integration with the initial deployment of DABS sensors is provided. The document discusses: the characteristics and use of the surveillance data, the exchange of messages between the ATC facility by means of the DABS air-ground data link and some potential applications, the interaction between ATARS and the ATC facility, and the exchange of information between DABS and the ATC facility relative to status and control information. The actions performed by the DABS sensor are summarized, the messages involved in the transactions between DABS and the ATC facility are described and the actions by the ATC facility are discussed. GRA

N80-28338* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A PILOTED SIMULATOR ANALYSIS OF THE CARRIER LANDING CAPABILITY OF THE QUIET SHORT-HAUL RESEARCH AIRCRAFT
Dennis W. Riddle Jul. 1980 41 p refs
(NASA-TM-78508; A-7528) Avail: NASA. Ames Res. Center, Moffett Field, Calif. 94035 CSCL 01C

A moving-base carrier landing simulation was conducted to evaluate the carrier landing capability of the Quiet Short-Haul Research Aircraft. Statistical results show that for an optimized approach configuration utilizing direct lift control, landings to a full stop can be safely executed (without use of arresting gear) with 40% of the landing deck remaining and without exceeding 50% of the design touchdown sink rate. Even under adverse sea state and wind conditions, the maximum allowable touchdown sink rate and minimum touchdown pitch attitude limits were never exceeded. Using the optimized approach configuration, successful go-arounds can be executed at any time during the approach, even when into the landing flare maneuver. L.F.M.

N80-28339*# Rensselaer Polytechnic Inst., Troy, N. Y. Composite Structural Program.
COMPOSITE STRUCTURAL MATERIALS Semiannual Report, Sep. 1979 - Apr. 1980
George S. Ansell, Robert G. Loewy, and Stephen E. Wiberley Jun. 1980 152 p refs Sponsored in part by AFOSR
(Grant NGL-33-018-003)
(NASA-CR-163377; SAR-38) Avail: NTIS HC A08/MF A01 CSCL 01C

The use of filamentary composite materials in the design and construction of primary aircraft structures is considered with emphasis on efforts to develop advanced technology in the areas of physical properties, structural concepts and analysis, manufacturing, and reliability and life prediction. The redesign of a main spar/rib region on the Boeing 727 elevator near its actuator attachment point is discussed. A composite fabrication and test facility is described as well as the use of minicomputers for computer aided design. Other topics covered include (1) advanced structural analysis methids for composites; (2) ultrasonic nondestructive testing of composite structures; (3) optimum combination of hardeners in the cure of epoxy; (4) fatigue in composite materials; (5) resin matrix characterization and properties; (6) postbuckling analysis of curved laminate composite panels; and (7) acoustic emission testing of composite tensile specimens. A.R.H.

N80-28340*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PARAMETRIC STUDY OF MODERN AIRSHIP PRODUCTIVITY
Mark D. Ardema and Kenneth Flaig Jul. 1980 52 p refs
(NASA-TM-81151; A-7993) Avail: NTIS HC A04/MF A01 CSCL 01C

A method for estimating the specific productivity of both hybrid and fully buoyant airships is developed. Various methods of estimating structural weight of deltoid hybrids are discussed and a derived weight estimating relationship is presented. Specific productivity is used as a figure of merit in a parametric study of fully buoyant ellipsoidal and deltoid hybrid semi-buoyant vehicles. The sensitivity of results as a function of assumptions is also determined. No airship configurations were found to have superior specific productivity to transport airplanes. L.F.M.

N80-28341*# National Aeronautics and Space Administration. *Ames Research Center, Moffett Field, Calif.*
A PILOT'S ASSESSMENT OF HELICOPTER HANDLING-QUALITY FACTORS COMMON TO BOTH AGILITY AND INSTRUMENT FLYING TASKS
Ronald M. Gerdes Jul. 1980 20 p refs
(NASA-TM-81217; A-8263) Avail: NTIS HC A02/MF A01 CSCL 01C

A series of simulation and flight investigations were undertaken to evaluate helicopter flying qualities and the effects of control system augmentation for nap-of-the-Earth (NOE) agility and instrument flying tasks. Handling quality factors common to both tasks were identified. Precise attitude control was determined to be a key requirement for successful accomplishment of both tasks. Factors that degraded attitude controllability were improper levels of control sensitivity and damping, and rotor system cross coupling due to helicopter angular rate and collective pitch input. Application of rate command, attitude command, and control input decouple augmentation schemes enhanced attitude control and significantly improved handling qualities for both tasks. The NOE agility and instrument flying handling quality considerations, pilot rating philosophy, and supplemental flight evaluations are also discussed. L.F.M.

N80-28342# Textron Bell Helicopter, Fort Worth, Tex.
CONCEPTUAL DESIGN OF A HELICOPTER COMPOSITE TRUSS TAIL BOOM Final Report
David A. Gallian Apr. 1980 118 p
(Contract DAAK51-78-C-0016; DA Proj. 1L1-62209-AH-76)
(AD-A085132; USAAVRADCOM-TR-80-D-8) Avail: NTIS HC A06/MF A01 CSCL 01/3

This report presents the results of a conceptual study of a helicopter composite truss tail boom. The study included the following tasks: design criteria, material properties, truss design and analysis, manufacturing techniques, and fabrication and ballistic testing. The results of the study indicate that a composite truss is a viable concept for a ballistically tolerant tail boom. GRA

N80-28343# Boeing Vertol Co., Philadelphia, Pa.
HEAVY LIFT HELICOPTER: PROTOTYPE TECHNICAL SUMMARY Final Report, Jan. 1973 - Aug. 1975

Apr. 1980 356 p refs
(Contract DAAJ01-71-C-0840)
(AD-A085290; D301-10323-1; USAAVRADCOM-TR-80-D-11)
Avail: NTIS HC A16/MF A01 CSCL 01/3

This report summarizes the Heavy Lift Helicopter (HLH) Prototype program. The program was designed to demonstrate, in the actual flight environment, the capabilities of HLH components previously developed by Boeing Vertol under the Advanced Technology Components (ATC) effort. Design, fabrication, and assembly of one prototype HLH was 90 percent completed. An advanced aluminum honeycomb airframe, landing gear, and subsystems not included in the ATC effort were designed and fabricated. Limited laboratory tests were conducted to assure airworthiness of the prototype aircraft. Mockups were constructed of the crew compartment and aft area. A description of the aircraft, discussion of the tests conducted, and weight and performance data are presented. A list of references containing detailed documentation of the program is appended. GRA

N80-28344# Lockheed-Georgia Co., Marietta.
PERIPHERAL JET AIR CUSHION LANDING SYSTEM SPANLOADER AIRCRAFT, VOLUME 1 Final Report, Jul. - Dec. 1979
J. W. Moore, L. Barnett, B. T. Farmer, E. E. McBride, B. I. Reynolds, and R. E. Stephens Wright-Patterson AFB, Ohio AFFDL Dec. 1979 154 p refs
(Contract F33615-79-C-3029; AF Proj. 2404)
(AD-A085203; LG79ER0177-Vol-1; AFFDL-TR-79-3152-Vol-1)
Avail: NTIS HC A08/MF A01 CSCL 01/2

Inherent in the design optimization of wing span-distributed load (spanloader) aircraft is the lack of ground operational down bending load reaction capability of the wing structure. It is necessary to provide a means to react these down bending loads if the wing structural weight is minimized. Recent studies have provided wide tread landing gears as a means to react these down bending loads, limiting the operational capability of the aircraft where the tread width exceeds most existing airport taxiway or runway widths. This study examines the feasibility of replacing the wide tread gear with a peripheral jet air cushion landing system (PJ-ACLS) in combination with a minimum tread (75 feet) width gear. The PJ-ACLS is located adjacent to the wing tip and is used primarily as wing down bending load reaction device. The minimum tread width gear is retained to simplify takeoff and landing procedures and to reduce the magnitude of the lift required from the PJ-ACLS. GRA

N80-28345# Lockheed-Georgia Co., Marietta.
PERIPHERAL JET AIR CUSHION LANDING SYSTEM SPANLOADER AIRCRAFT, VOLUME 2 Final Report, Jul. - Dec. 1979
J. W. Moore, L. Barnett, B. T. Farmer, E. E. McBride, B. I. Reynolds, and R. E. Stephens Wright-Patterson AFB, Ohio AFFDL Dec. 1979 298 p refs
(Contract F33615-79-C-3029; AF Proj. 2404)
(AD-A085117; LG79ER0177-Vol-2; AFFDL-TR-79-3152-Vol-2)
Avail: NTIS HC A13/MF A01 CSCL 01/2

The output of a computerized peripheral jet cushion landing system performance program is presented. The input matrix evaluated is as follows: cushion length (%b/2); cushion load or lift (%GW); jet toe-in angle (theta) degrees; and jet thickness (t) inches. These input data are evaluated for the baseline Spanloader configuration where cushion and landing gear are reduced by 40 inches to represent a configuration which incorporates a flat bottom airfoil shape. R.C.T.

N80-28346# Societe Nationale Industrielle Aerospatiale, Toulouse (France). Directions Etudes.
TRANSPARENT MATERIALS FOR CIVIL AIRCRAFT [OBJET: TRANSPARENTS POUR AVIONS CIVILS]
Frustie Paris 26 Mar. 1979 33 p In FRENCH Presented at Assoc. Aeron. et Astronautique de France/ONERA Conf., 29 Mar. 1979
(SNIAS-792-111-108) Avail: NTIS HC A03/MF A01

The characteristics required for both windshields and port windows subsonic and supersonic aircraft are described. The following subjects are treated: nature of materials and systems used, quality requirements (pressure and impact resistance, optical properties, endurance, defrosting possibilities, weight, resistance to abrasion manufacturing techniques and heat treatments. The evolution that has taken place over recent years in the design of such systems and in the materials used is discussed together with experience with A 300 B material and future developments expected in this field. Author (ESA)

N80-28347# Societe Nationale Industrielle Aerospatiale, Marignane (France.) Div. Helicopteres.
IMPACT OF MODERN MATERIALS ON THE DEVELOPMENT OF HELICOPTERS [IMPACTS DES MATERIAUX MODERNES SUR LE DEVELOPPEMENT DES APPAREILS A VOILURES TOURNANTES]
G. Petit and F. dAmbra Paris 1979 35 p In FRENCH
(SNIAS-792-210-123) Avail: NTIS HC A03/MF A01

The modern materials (plastics, composite materials, etc.) currently used in the construction of helicopters are presented. A review is given of the main objectives sought by the contractor: reduction of mass and costs, and improving performance and operational characteristics. Emphasis is given to the special techniques and procedures (both design and industrial manufacturing phases) employed together with the quality control and operational behavior studies performed. Author (ESA)

N80-28348# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
TECHNICAL EVALUATION REPORT ON THE FLIGHT MECHANICS PANEL SYMPOSIUM ON THE USE OF COMPUTERS AS A DESIGN TOOL
Siegfried N. Wagner (Hochschule der Bundeswehr, Munich) Mar. 1980 21 p refs Symp. presented at Munich, 3-6 Sep. 1979
(AGARD-AR-158; ISBN-92-835-1353-3) Avail: NTIS HC A02/MF A01

The application of computer technology to aircraft design is considered. Specific topics covered include: specifications and assessment of requirements; computer aided design and computer graphics; computational aerodynamics and design; structural analysis and design; and propulsion and systems design. The primary conclusions are that the human being still plays a critical role during all steps of computerized aircraft design and that remarkable progress has been made in many areas related to aircraft design because of recent developments in computer hardware and software. However, there are still areas where the designer has to relay rely on wind tunnel and structural testing. The computer has reduced the routine workload of the engineer to save time for creative work, but there is still a need for faster and larger computers that will probably incorporate new architectures. J.M.S.

N80-28349*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
AN EXPERIMENTAL EVALUATION OF HEAD-UP DISPLAY FORMATS
J. M. Naish and Donna L. Miller (Informatics, Inc., Palo Alto, Calif.) Jul. 1980 78 p refs
(NASA-TP-1550; A-7970) Avail: NTIS HC A05/MF A01 CSCL 01D

Three types of head-up display format are investigated. Type 1 is an unreferenced (conventional) flight director, type 2 is a ground referenced flight path display, and type 3 is a ground referenced director. Formats are generated by computer and presented by reflecting collimation against a simulated forward view in flight. Pilots, holding commercial licenses, fly approaches in the instrument flight mode and in a combined instrument and visual flight mode. The approaches are in wind shear with varied conditions of visibility, offset, and turbulence. The displays are equivalent in pure tracking but there is a slight advantage for the unreferenced director in poor conditions. Flight path displays are better for tracking in the combined flight mode, possibly because of poor director control laws and the division of attention between superimposed fields. Workloads is better for the type 2 displays. The flight path and referenced director displays are criticized for effects of symbol motion and field limiting. In the

subjective judgment of pilots familiar with the director displays, they are rated clearly better than path displays, with a preference for the unreferenced director. There is a fair division of attention between superimposed fields. Author

N80-28350# Intermetrics, Inc., Dayton, Ohio.
DIGITAL AVIONICS INFORMATION SYSTEM (DAIS): MISSION SOFTWARE Final Report, 23 Jun. 1975 - 28 Feb. 1979
W. H. Vandever, Jr., S. F. Stanten, P. Y. Williams, D. A. Flanders, S. Z. Stein, S. E. Adams, and N. Eastridge Wright-Patterson AFB, Ohio AFWAL Feb. 1980 153 p refs
(Contract F33615-75-C-1181; AF Proj. 2092)
(AD-A085136; AFWAL-TR-80-1003) Avail: NTIS HC A08/MF A01 CSCL 09/3

The significance of this research and development to the Air Force is the demonstration of the applicability of modern software techniques and methodology to the generation of sophisticated, flexible avionics software with excellent life cycle costs and easy maintainability. The DAIS Mission Software was coded in J73/I and based its structure upon the relocatability concepts known as Higher Order Software (HOS). GRA

N80-28351# Sikorsky Aircraft, Stratford, Conn.
ADVANCED SUBSYSTEM STATUS MONITOR Final Report, Oct. 1978 - Oct. 1979
J. McGee and H. Harper Apr. 1980 262 p
(Contract DAAK51-78-C-0023; DA Proj. 1L1-62209-AH-76)
(AD-A085135; SER-510025; USAAVRADCOM-TR-80-D-5)
Avail: NTIS HC A12/MF A01 CSCL 01/3

Five tasks were completed toward the design of an advanced Subsystem Status Monitor that will reduce crew workload during the monitoring of helicopter subsystems: (1) analysis of parameters currently monitored in the UH-60A, CH-47C, OH-58C, and AH-1G Army helicopters, and recommendation of information requirements for these helicopters; (2) development of prioritization, logic, and display formats for the presentation of subsystem information on multi-function electronic displays for the above-mentioned helicopters; (3) preliminary design of system architectures incorporating state-of-the-art, near-term and long-term technologies into an advanced Subsystem Status Monitor; (4) evaluation of preliminary designs to determine predicted impacts on flight safety, workload, reliability and maintainability, survivability and vulnerability, aircraft space and volume, aircraft weight, and life cycle costs; (5) design of keyboard and associated display formats for the following peripheral functions: checklist presentation, performance calculation, and load monitoring. GRA

N80-28352*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OFF-DESIGN CORRELATION FOR LOSSES DUE TO PART-SPAN DAMPERS ON TRANSONIC ROTORS
William B. Roberts, James E. Crouse, and Donald M. Sandercock Jul. 1980 24 p refs
(NASA-TP-1693; E-309) Avail: NTIS HC A02/MF A01 CSCL 21E

Experimental data from 10 transonic fan rotors were used to correlate losses created by part-span dampers located near the midchord position on the rotor blades. The design tip speed of these rotors varied from 419 to 425 m/sec, and the design pressure ratio varied from 1.6 to 2.0. Additional loss caused by the dampers for operating conditions between 50 and 100 percent of design speed were correlated with relevant aerodynamic and geometric parameters. The resulting correlation predicts the variation of total-pressure-loss coefficient in the damper region to a good approximation. Author

N80-28353*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PERFORMANCE ESTIMATION FOR HIGHLY LOADED SIX AND TEN BLADE PROPELLERS COMBINED WITH AN ADVANCED TECHNOLOGY TURBOSHAFT ENGINE
Shelby J. Morris, Jr. Jun. 1980 22 p refs
(NASA-TM-81840) Avail: NTIS HC A02/MF A01 CSCL 21E

Performance estimations, weights, and scaling laws for the six blade and ten blade highly loaded propellers combined with an advanced turboshaft engine are presented. These data are useful for aircraft mission studies using the turboprop system. Comparisons are made between the performance of post 1980 technology turboprop propulsion systems and the performance of both a current technology turbofan and a post 1990 technology turbofan. Author

N80-28354# General Accounting Office, Washington, D. C. Procurement and Systems Acquisition Div.
IS THE JOINT AIR FORCE/NAVY ALTERNATE ENGINE PROGRAM WORKABLE? GAO THINKS NOT, AS PRESENTLY STRUCTURED
9 May 1980 34 p
(AD-A084709; GAO/PSAD-80-40) Avail: NTIS HC A03/MF A01 CSCL 21/5

This report describes the joint Air Force/Navy alternate engine program and discusses the need to (1) identify program objectives and (2) structure the program on a realistic basis that avoids taking overly ambitious steps under the guise of a modification program. The report also suggests that the program as presently conceived may not satisfy the directive of the Defense Appropriations Conference Committee and perhaps should be terminated. Our review of the joint services' alternate engine program is part of an overall review of the Department of Defense's acquisition process for aircraft gas turbine engines. The alternate engine program is one of the first derivative fighter engine programs initiated under the Air Force's new concept for engine development GRA

N80-28355# Lincoln Lab., Mass. Inst. of Tech., Lexington.
REMOTE SENSING OF TURBINE ENGINE GASES Final Report, 15 Jul. 1978 - 30 Sep. 1979
Aram Morradian, Dennis K. Killinger, and Norman Menyuk 30 Sep. 1979 84 p refs
(Contract F19628-78-C-0002)
(AD-A084544; ESD-TR-79-319; AFESC/ESL-TR-80-09) Avail: NTIS HC A05/MF A01 CSCL 20/5

This document is the final report for a laser remote sensing research program. The research conducted was designed to develop and demonstrate laser remote sensing techniques for monitoring jet aircraft exhaust gases. This effort was part of a larger program to develop remote sensing techniques for environmental monitoring and tactical detection and discrimination. The specific tasks which were performed consisted of the following: (1) development of an improved repetition rate miniature CO2 TEA laser and incorporation into a differential-absorption LIDAR(DIAL) system, (2) laboratory demonstration of the frequency-doubled CO2 TEA laser system by differential-absorption measurements of known gas samples (CO and NO), and (3) initial field feasibility demonstration of laser remote detection of CO in vehicular exhaust (automobile, tractor mower and Skycrane helicopter) at ranges up to 2.5 km. Each of these tasks is described in detail in the following sections of this report. In addition, supportive documentation is included in the accompanying appendices. GRA

N80-28356# Naval Postgraduate School, Monterey, Calif.
EFFECTS OF FUEL ADDITIVES ON PLUME OPACITY OF A SUBSCALE TURBOJET TEST CELL WITH A RAMJET TYPE DUMP COMBUSTOR M.S. Thesis
Thomas Richard Darnell Dec. 1979 77 p refs
(AD-A084516) Avail: NTIS HC A05/MF A01 CSCL 21/5

An initial investigation was conducted into the effects of metallic based fuel additives on smoke reduction in turbojet test cells. Experiments were conducted on a one-eighth scale turbojet test cell with a ramjet type pump-combustor. Measurements of particle sizes and concentrations were made using light transmittance at two wavelengths. Particulate samples were collected and examined with a scanning electron microscope. Increased combustor temperatures and fuel additives appeared to affect particle size and concentration primarily downstream of the engine exhaust. Recommendations are made for experimental technique improvements which are required to improve the quality of data. GRA

N80-28358# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio. Aerospace Power Div.
COMPUTER SIMULATION OF AUXILIARY POWER SYSTEMS Final Technical Report, 1 Jul. 1974 - 30 Nov. 1979
Daniel J. Gurecki Mar. 1980 66 p refs
(AF Proj. 3145)
(AD-A084858; AFAPL-TR-79-2118) Avail: NTIS HC A04/MF A01 CSCL 10/2

A digital computer program for the analysis of Auxiliary Power Units (APUs) has been developed. It analyzes the thermodynamics of each component, compressor, combustor, and turbine with regards to basic performance parameters and bleed leakage flows. On the first pass, the code solves the available horsepower from the APU on the basis of input component pressure ratio and efficiencies. On the second pass, the component performance is solved to satisfy the desired design shaft horsepower of the APU. This code is called APU code. GRA

N80-28359# Naval Postgraduate School, Monterey, Calif.
A COMPARISON OF SOLID FUEL RAMJET FLOW CHARACTERISTICS AND COMBUSTION BEHAVIOR M.S. Thesis
Brian Andrew Binn Dec. 1979 83 p refs Sponsored by Naval Weapons Center
(AD-A085064) Avail: NTIS HC A05/MF A01 CSCL 21/5

An experimental investigation was conducted to determine if there is a relationship between the cold flow characteristics of velocity, pressure distribution, and turbulence intensity and the reacting flow performance and combustion characteristics of a solid fuel ramjet. The effects of configuration and air flow changes on the above characteristics were examined. Average regression rates and combustion efficiencies were not significantly affected by changes in configuration. These variations in test conditions significantly affected the center-line turbulence intensity but not the near-wall turbulence intensity in cold flow. The use of bypass resulted in decreases in regression rate and efficiencies for all cases. Attainable performance appears to be most strongly related to near-wall turbulence intensity/mixing and to the amount of fuel reaching the aft mixing chamber. GRA

N80-28361# DyTec Engineering, Inc., Huntington Beach, Calif.
REVIEW OF TURBOFAN-ENGINE COMBUSTION AND JET-NOISE RESEARCH AND RELATED TOPICS Final Report
Alan H. Marsh and Gary L. Blankenship Jan. 1980 125 p refs
(AD-A085176; DYTEC-7936; FAA-RD-80-16) Avail: NTIS HC A06/MF A01 CSCL 21/5

In the early 1970s, internal sources of noise in jet engines were identified as being potentially strong enough to affect the levels of jet-aircraft noise at the Far Part 36 noise-certification points. These internal sources have a broadband spectrum and are not related to the rotating turbomachinery components within the engine. A review of the status of jet- and core-engine noise research was held at FAA Headquarters in the Fall of 1974. Subsequent to that status review, the FAA sponsored additional studies of combustion noise. Also, during this period, a significant study of jet noise produced by high-velocity jets was conducted under the initial sponsorship of DOT, and then of FAA. The high-velocity jet-noise study included extensive analytical and experimental investigations of jet-noise suppressors as well as studies of the effects of forward motion on jet-engine noise. In February 1977, the FAA and the DOT held a second conference at FAA Headquarters to review the status of jet- and combustion-noise research. The conference was attended by representatives from Government and industry and presentations were made of contracted and independent research studies. This report reviews the research findings presented at the February 1977 Jet/Combustion-Noise Research Conference as well as subsequent to the conference through June 1979. GRA

N80-28362# Solar Turbines International, San Diego, Calif.
DEVELOPMENT AND EVALUATION OF PROCESSES FOR DEPOSITION OF Ni/Cr-AlY (MCrAlY) COATINGS FOR GAS TURBINE COMPONENTS Final Report, 1 Nov. 1976 - 1 Sep. 1978
L. Hsu, W. G. Stevens, and A. R. Stetson Wright-Patterson AFB, Ohio AFML Sep. 1979 154 p refs
(Contract F33615-76-C-5379; AF Proj. 7312)
(AD-A085197; SR79-R-4571-18; AFML-TR-79-4097) Avail: NTIS HC A08/MF A01 CSCL 21/5

The controlled composition reaction sintered MCrAlY process was developed as a cost effective, non-line-of-sight (LOS) alternative to the physical vapor deposition (PVD) coating process. The technique was developed for coating complex clustered airfoil configurations and the mechanical, thermal shock, and environmental properties of the coatings were evaluated relative to commercially available PVD coatings. The controlled composition reaction sintered process can be either LOS or non-LOS, depending on geometry. The former consists of slurry spraying the CoNiCrAlY powder onto the cleaned part followed by reaction sintering in a controlled activity aluminized pack. The latter utilizes an electrophoretic fluidized bed approach to nickel-base alloys. Full densification of the CoNiCrAlY coating was achieved. However, the coating had greater porosity on cobalt-base X-40 alloy.
J.M.S.

N80-28363# Gates Learjet Corp., Wichita, Kans.
ENGINE INLET ANTI-ICING SYSTEM EVALUATION PROCEDURE Final Report
Allyn Heinrich, Richard Ross, and Nick Ganesan Jan. 1980 143 p refs
(Contract DOT-FA76WA-3852)
(AD-A085179; FAA-RD-80-50) Avail: NTIS HC A07/MF A01 CSCL 21/5

The objectives of this work were to develop a procedure for predicting and evaluating the performance of engine inlet anti-icing systems for compliance with FAR 25 ice protection requirements without conducting flight tests in natural icing conditions. This must include consideration of water droplet impingment, collection efficiency, internal and external heat transfer, and mass transfer of the impinging water. The method of approach for developing these procedures was to survey current analysis methods involving physical theory and empirical methods and then to develop a computerized model for use in anti-icing system performance analysis. Icing wind tunnel tests were conducted using a three dimensional nacelle test model to aid in the procedure development. A typical engine-inlet anti-icing system was evaluated with the computer model in a variety of icing environments and operational conditions and compared with icing wind tunnel test results. Correlation between performance predictions and wind tunnel test results was found to have good agreement within the spectrum of conditions that were practicable in the wind tunnel. GRA

N80-28364# National Aviation Facilities Experimental Center, Atlantic City, N. J.
EXHAUST EMISSIONS CHARACTERISTICS FOR A GENERAL AVIATION LIGHT-AIRCRAFT AVCO LYCOMING O-320/IO-320-DIAD PISTON ENGINE Final Report
Eric E. Becker Apr. 1980 125 p refs
(FAA Proj. 201-521-100)
(AD-A084933; FAA-NA-79-45) Avail: NTIS HC A06/MF A01 CSCL 13/2

The Avco Lycoming O-320/IO-320-DIAD engine (S/N889-X) was tested at the National Aviation Facilities Experimental Center (NAFEC) to develop an exhaust emissions data base. This data base consists of current production baseline emissions characteristics, lean-out emissions data, effects of leaning-out the fuel schedule on cylinder head temperatures, and data showing ambient effects on exhaust emissions and cylinder head temperatures. The engine operating with its current full-rich production fuel schedule could not meet the proposed Environmental Protection Agency (EPA) standard for carbon monoxide (CO) under sea level standard-day conditions. The engine did, however, meet the proposed EPA standards for unburned hydrocarbons (HC) and oxides of nitrogen (NO(x)) under sea level standard-day conditions. The results of engine testing under different ambient conditions are also presented, and these results show a trend toward higher levels of emissions output for CO and HC under warm or hot day conditions while producing slightly lower levels of NO(x). GRA

N80-28365# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.
CUMULATIVE DAMAGE FRACTURE MECHANICS UNDER ENGINE SPECTRA Final Report, 1 Sep. 1977 - 31 Jan. 1980
J. M. Larsen, B. T. Schwartz, and C. G. Annis, Jr. Jan. 1980 234 p refs
(Contract F33615-77-C-5153; AF Proj. 2420)
(AD-A084934; PWA-FR-11844; AFML-TR-79-4159) Avail: NTIS HC A11/MF A01 CSCL 21/5

An empirically based mathematical model and computer code capable of predicting cumulative damage effects on fatigue crack growth in engine disks has been developed for Waspaloy (PWA 1007) and IN100 (PWA 1073). The computing software segregates a complex loading mission, applies a multi-parameter interpolation procedure to determine cycle-by-cycle crack growth, and performs a specimen life calculation. The model was developed from a broad matrix of tests of both materials, and a number of auxiliary investigations were conducted to examine the range of applicability of the model. GRA

N80-28369*# United Technologies Research Center, East Hartford, Conn.
ANALYTICAL DESIGN AND EVALUATION OF AN ACTIVE CONTROL SYSTEM FOR HELICOPTER VIBRATION REDUCTION AND GUST RESPONSE ALLEVIATION
R. B. Taylor, P. E. Zwicke, P. Gold, and W. Miao Jul. 1980 165 p refs Prepared in cooperation with Sikorsky Aircraft, Stratford, Conn.
(Contract NAS2-10121)
(NASA-CR-152377) Avail: NTIS HC A08/MF A01 CSCL 01C

An analytical study was conducted to define the basic configuration of an active control system for helicopter vibration and gust response alleviation. The study culminated in a control system design which has two separate systems: narrow band loop for vibration reduction and wider band loop for gust response alleviation. The narrow band vibration loop utilizes the standard swashplate control configuration to input controller for the vibration loop is based on adaptive optimal control theory and is designed to adapt to any flight condition including maneuvers and transients. The prime characteristics of the vibration control system is its real time capability. The gust alleviation control system studied consists of optimal sampled data feedback gains together with an optimal one-step-ahead prediction. The prediction permits the estimation of the gust disturbance which can then be used to minimize the gust effects on the helicopter. E.D.K.

N80-28370*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EXPLORATORY PILOTED SIMULATOR STUDY OF THE EFFECTS OF WINGLETS ON HANDLING QUALITIES OF A REPRESENTATIVE AGRICULTURAL AIRPLANE
Marilyn E. Ogbury and Philip W. Brown Apr. 1980 44 p refs
(NASA-TM-81817) Avail: NTIS HC A03/MF A01 CSCL 01C

The effects on handling qualities of adding winglets to a representative agricultural aircraft configuration during swath-run maneuvering were evaluated. Aerodynamic data used in the simulation were based on low-speed wind tunnel tests of a full scale airplane and a subscale model. The Cooper-Harper handling qualities rating scale, supplementary pilot comments, and pilot vehicle performance data were used to describe the handling qualities of the airplane with the different wing-tip configurations. Results showed that the lateral-directional handling qualities of the airplane were greatly affected by the application of winglets and winglet cant angle. The airplane with winglets canted out 20 deg exhibited severely degraded lateral directional handling qualities in comparison to the basic airplane. When the winglets were canted inward 10 deg, the flying qualities of the configuration were markedly improved over those of the winglet-canted-out configuration or the basic configuration without winglets, indicating that proper tailoring of the winglet design may afford a potential benefit in the area of handling qualities. L.F.M.

N80-28371*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A MATHEMATICAL REPRESENTATION OF AN ADVANCED HELICOPTER FOR PILOTED SIMULATOR INVESTIGATIONS OF CONTROL SYSTEM AND DISPLAY VARIATIONS
Edwin W. Aiken Jul. 1980 51 p refs
(NASA-TM-81203; AVRADCOM-TM-80-A-02; A-8194) Avail: NTIS HC A04/MF A01 CSCL 01C

A mathematical model of an advanced helicopter is described. The model is suitable for use in control/display research involving piloted simulation. The general design approach for the six degree of freedom equations of motion is to use the full set of nonlinear gravitational and inertial terms of the equations and to express the aerodynamic forces and moments as the reference values and first order terms of a Taylor series expansion about a reference trajectory defined as a function of longitudinal airspeed. Provisions for several different specific and generic flight control systems are included in the model. The logic required to drive various flight control and weapon delivery symbols on a pilot's electronic display is also provided. Finally, the model includes a simplified representation of low altitude wind and turbulence effects. This model was used in a piloted simulator investigation of the effects of control system and display variations for an attack helicopter mission. L.F.M.

N80-28373*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. Flight Research Lab.
A SUMMARY OF JOINT US-CANADIAN AUGMENTOR WING POWERED-LIFT STOL RESEARCH PROGRAMS AT THE AMES RESEARCH CENTER, NASA, 1975-1980
W. S. Hindson (National Research Council of Canada, Ottawa) and G. Hardy Jul. 1980 64 p refs Presented at Canadian Aeron. Inst. Meeting, Ottawa, 25-26 Mar. 1980
(NASA-TM-81215; LTR-FR-75) Avail: NTIS HC A04/MF A01 CSCL 01C

Several different flight research programs carried out by NASA and the Canadian Government using the Augmentor Wing Jet STOL Research Aircraft to investigate the design, operational, and systems requirements for powered-lift STOL aircraft are summarized. Some of these programs considered handling qualities and certification criteria for this class of aircraft, and addressed pilot control techniques, control system design, and improved cockpit displays for the powered-lift STOL approach configuration. Other programs involved exploiting the potential of STOL aircraft for constrained terminal-area approaches within the context of present or future air traffic control environments. Both manual and automatic flight control investigations are discussed, and an extensive bibliography of the flight programs is included. Author

N80-28374# Scientific Systems, Inc., Cambridge, Mass.
GLOBAL STABILITY AND CONTROL ANALYSIS OF AIRCRAFT AT HIGH ANGLES OF ATTACK Annual Technical Report, 1 Jun. 1978 - 31 May 1979
Raman K. Mehra and James V. Carroll Aug. 1979 348 p refs
(Contract N00014-76-C-0780)
(AD-A084938; ONR-CR-215-245-3; ATR-3) Avail: NTIS HC A15/MF A01 CSCL 20/4

High angle-of-attack phenomena have been of interest to aerodynamicists, aircraft designers, pilots and control system analysts ever since the advent of modern high performance aircraft. Due to the concentration of inertia along the fuselage, the modern jet fighters are highly susceptible to poststall departures and spin. In spite of extensive design effort, modern aircraft still inadvertently enter spins which sometimes result in loss of life and/or property. Extensive wind-tunnel testing and radio-controlled flight testing has been done over the last 20 years to gain a better understanding of the dynamic instabilities at high angles-of-attack. A basic problem has existed in interpreting these data and in making predictions of aircraft dynamic behavior so as to achieve close agreement with flight test data. Most of the work on this project involved a study of the second aircraft model, the F-4. A detailed description of modeling this aircraft, correlation time history runs, and a high angle-of-attack analysis utilizing equilibrium and bifurcation surfaces, is included in this report. The equilibrium spin regimes were found to be rather

insensitive to aerosurface control deflections, a result consistent with observed performance. Studies were conducted as well in the stall/post-stall/spin entry regime, a control synthesis approach was initiated, and thrust effects were analyzed. GRA

N80-28375# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio. Flight Control Div.
FLYING QUALITIES DESIGN REQUIREMENTS FOR SIDESTICK CONTROLLERS Final Report, Oct. 1978 - Aug. 1979
G. Thomas Black and David J. Moorehouse Oct. 1979 186 p refs
(AF Proj. 2403)
(AD-A085085; AFFDL-TR-79-3126) Avail: NTIS HC A09/MF A01 CSCL 01/2

Five flight test experiments using the variable stability NT-33A were sponsored by AFWAL/FIGC from May 1977 to June 1979, conducted by students of the Air Force Test Pilot School. This data has been correlated with previously published flying qualities information to form guidance on design of sidestick controllers. Preferred force and deflection gradients are indicated. There is an apparent influence of short-period frequency and roll mode time constant on the preferred sidestick characteristics. The results presented and discussed are for fighter configurations and tasks. The very limited amount of data on transport airplanes is discussed. The implications to the flying qualities specification are discussed, but it is concluded that there is insufficient data to formulate requirements. Data from the AFTPS experiments is presented in appendices to this report. GRA

N80-28377*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN ASSESSMENT OF THE FUTURE ROLES OF THE NATIONAL TRANSONIC FACILITY AND THE LANGLEY TRANSONIC DYNAMICS TUNNEL IN AEROELASTIC AND UNSTEADY AERODYNAMIC TESTING
Perry W. Hanson Jun. 1980 52 p refs
(NASA-TM-81839) Avail: NTIS HC A04/MF A01 CSCL 14B

The characteristics and capabilities of the two tunnels, that relate to studies in the fields of aeroelasticity and unsteady aerodynamics are discussed. Scaling considerations for aeroelasticity and unsteady aerodynamics testing in the two facilities are reviewed, and some of the special features (or lack thereof) of the Langley Research Center Transonic Dynamics Tunnel (TDT) and the National Transonic Facility (NTF) that will weigh heavily in any decisions conducting a given study in the two tunnels are discussed. For illustrative purposes a fighter and a transport airplane are scaled for tests in the NTF and in the TDT, and the resulting model characteristics are compared. The NTF was designed specifically to meet the need for higher Reynolds number capability for flow simulation in aerodynamic performance testing of aircraft designs. However, the NTF can be a valuable tool for evaluating the severity of Reynolds number effects in the areas of dynamic aeroelasticity and unsteady aerodynamics. On the other hand, the TDT was constructed specifically for studies and tests in the field of aeroelasticity. Except for tests requiring the Reynolds number capability of NTF, the TDT will remain the primary facility for tests of dynamic aeroelasticity and unsteady aerodynamics. L.F.M.

N80-28378# Naval Postgraduate School, Monterey, Calif.
ANALYSIS AND TESTING TO IMPROVE THE FLOW FROM THE PLENUM OF A SUBSONIC CASCADE WIND TUNNEL M.S. Thesis
Richard Carl Moebius Mar. 1980 133 p refs
(AD-A084471) Avail: NTIS HC A07/MF A01 CSCL 14/2

The original design of the plenum and bellmouth contraction arrangement of a subsonic cascade test facility did not produce sufficiently uniform flow conditions at the bellmouth exit plane. Pneumatic measurements revealed sizeable blade-to-blade variations in velocity and flow angle. A finite element numerical analysis of the inviscid flow field was carried out which both confirmed the need for and guided the design of a modification to the bellmouth contraction from the plenum. Following the modifications, in which the original contraction was changed to two two dimensional contractions in series, and a program of development tests, acceptably small variations in velocity and flow angle were measured at the bellmouth exit plane. GRA

N80-28379# Seville Research Corp., Pensacola, Fla.
DEVELOPMENT OF SIMULATOR INSTRUCTIONAL FEATURE DESIGN GUIDES Interim Report
Paul W. Caro, Lawrence D. Pohlmann, and Robert N. Isley Oct. 1979 74 p refs
(Contract F49620-77-C-0112; AF Proj. 2313)
(AD-A084428; SEVILLE-TR-79-12; AFOSR-80-0345TR) Avail: NTIS HC A04/MF A01 CSCL 05/9

A project to develop guides for the design of simulator instructional features is described. Twelve instructional features, e.g., record/playback, automatic demonstration, and freeze, appropriate to a fighter/attack type aircraft simulator were identified. Information concerning each feature was obtained through observation of simulator instructional activities and review of training requirements and practices. The types of pilots likely to undergo training in a fighter/attack aircraft were examined to identify learner related simulator design requirements. A guide format was developed that would permit organization of pertinent information in a manner useful to simulator design personnel. The guides were reviewed by personnel involved in the development of both aircraft and non-aircraft simulators and were judged useful as a mechanism for clarifying design requirements, communicating between training and simulator design personnel, highlighting design shortfalls, and clarifying simulator testing requirements. GRA

N80-28380# General Applied Science Labs., Inc., Westbury, N. Y.
R2D2: A FORTRAN PROGRAM FOR TWO-DIMENSIONAL CHEMICALLY REACTING, HYPERTHERMAL, INTERNAL FLOWS. VOLUME 1: METHOD OF ANALYSIS Final Report, May 1978 - Sep. 1979
John Erdos, Gabriel Miller, Robert Ray, and Gertrude Weilerstein Wright-Patterson AFB, Ohio AFFDL Jan. 1980 50 p refs
(Contract F33615-78-C-3016; AF Proj. 2404)
(AD-A085225; GASL-TR-254-Vol-1; AFFDL-TR-79-3162-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 20/4

The theoretical formulation and method of analysis employed in the development of the FORTRAN program R2D2 is described. The program is capable of solving the two dimensional (planar or axisymmetric) internal flow of a chemically reacting and/or vibrationally excited mixture of gases in a nonequilibrium or equilibrated state. The local Mach number at the entrance and exit stations of the duct may be either subsonic or supersonic, although an arc-driven expanding flow, consisting of a subsonic reservoir, a transonic throat, and a supersonic expansion, is presumed to be the configuration of primary interest. Discontinuites in wall slope are admissible. The axisymmetric formulation includes a swirl component of velocity, in addition to the axial and radial components, which may be significant in swirl-stabilized arc facilities. The current version of R2D2 incorporates a thermochemical data package for an 8 species, 10 chemical reaction model of high temperature air, including ionization and vibrational excitation. However, the number of species and reactions is only limited by considerations of computer storage and running time, which can be formidable. GRA

N80-28381# Naval Civil Engineering Lab., Port Hueneme, Calif.
TRAFFIC TESTING OF A FIBERGLASS-REINFORCED POLYESTER RESIN SURFACING FOR RAPID RUNWAY REPAIR Final Report, Oct. 1978 - Sep. 1979
P. S. Springston Feb. 1980 44 p refs
(YF60536001)
(AD-A085288; CEL-TN-1572) Avail: NTIS HC A03/MF A01 CSCL 01/5

This report documents traffic tests of a fiberglass-reinforced polyester resin (FRP) membrane, conducted at the Rapid-Runway Repair Test Facility of the Air Force Engineering and Services Center at Tyndall Air Force Base, Fla. The membrane functions primarily as a trafficable cap, preventing foreign object damage to aircraft, over a backfilled bomb crater. The membrane also

reduces rutting, from rolling aircraft wheels, in a 24 in. thick crushed limestone base course overlaying backfilled debris. In the tests, applied traffic consisted of 150 and 20 coverages of load carts simulating F-4 and C-141 aircraft main gears, respectively. Experimentally recorded soil strain and surfacing deflection data are compared with predictions formulated previously, in which the finite element method of structural analysis was used. Recommendations are provided for further evaluation necessary for the certification of the concept for rapid runway repair. GRA

N80-28383# Open Univ., Milton (England). Energy Research Group.
THE THIRD LONDON AIRPORT: TO BUILD OR NOT TO BUILD
David Crabbe Jul. 1979 30 p refs
(ERG-029) Avail: NTIS HC A03/MF A01; Secr. Energy Res. Group, Milton Keynes, England

A statistical analysis of London air cargo and passenger traffic, a study of previously made traffic forecasts, and an examination of existing airport capacity were made. It is concluded that the primary traffic handling problem in the area is passenger throughput, not aircraft movements. Past forecasts of airport requirements have consistently overestimated growth in passenger traffic. Economic conditions foreseen for the 1980's demand flexibility, and there is no requirement whatsoever for a third airport development plan in the London area in the foreseeable future. Author (ESA)

N80-28436*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SELECTED NASA RESEARCH IN COMPOSITE MATERIALS AND STRUCTURES
1980 237 p refs Presented at the 2d Ind. Rev. of the NASA Aircraft Energy Efficiency (ACEE) Composite Programs, Seattle, 11-13 Aug. 1980
(NASA-CP-2142; L-13915) Avail: NTIS HC A15/MF A01 CSCL 11D

Various aspects of the application of composite materials to aircraft structures are considered. Failure prediction techniques, buckling and postbuckling research, laminate fatigue analysis, damage tolerance, high temperature resin matrix composites and electrical hazards of carbon fiber composites are among the topics discussed.

N80-28438*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
BUCKLING AND POSTBUCKLING RESEARCH ON FLAT AND CURVED COMPOSITE PANELS
James H. Starnes, Jr. *In its* Selected NASA Res. in Composite Mater. and Struct. 1980 p 35-78 refs

Avail: NTIS HC A15/MF A01 CSCL 11D

Progress in the development of verified design technology for generic advanced-composite structural components loaded in compression is reported. Generic structural configurations material systems and load ranges of interest for a given application were investigated using structural procedures, structural analysis procedures, and laboratory testing of structural specimens. Both flat and curved composite compression panels that are designed either to be buckling resistant or to have postbuckling strength depending on the expected application of the panels were considered. J.M.S.

N80-28441*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HIGH TEMPERATURE RESIN MATRIX COMPOSITES FOR AEROSPACE STRUCTURES
John G. Davis, Jr. *In its* Selected NASA Res. in Composite Mater. and Struct. 1980 p 143-182 refs

Avail: NTIS HC A15/MF A01 CSCL 11D

Accomplishments and the outlook for graphite-polyimide composite structures are briefly outlined. Laminates, skin-stiffened and honeycomb sandwich panels, chopped fiber moldings, and structural components were fabricated with Celion/LARC-160 and Celion/PMR-15 composite materials. Interlaminar shear and flexure strength data obtained on as-fabricated specimens and specimens that were exposed for 125 hours at 589 K indicate that epoxy sized and polyimide sized Celion graphite fibers exhibit essentially the same behavior in a PMR-15 matrix composite. Analyses and tests of graphite-polyimide compression and shear panels indicate that utilization in moderately loaded applications offers the potential for achieving a 30 to 50 percent reduction in structural mass compared to conventional aluminum panels. Data on effects of moisture, temperature, thermal cycling, and shuttle fluids on mechanical properties indicate that both LARC-160 and PMR-15 are suitable matrix materials for a graphite-polyimide aft body flap. No technical road blocks to building a graphite-polyimide composite aft body flap are identified. J.M.S.

N80-28442*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN INVESTIGATION OF POSSIBLE ELECTRICAL HAZARDS OF CARBON FIBER COMPOSITES
Robert J. Huston *In its* Selected NASA Res. in Composite Mater. and Struct. 1980 p 183-234 refs

Avail: NTIS HC A15/MF A01 CSCL 11D

Results of an assessment of the public risk associated with the release of carbon fibers from crash-fire accidents of civil aircraft having carbon composite structures are presented. The overall national impact is shown to be extremely low in 1993. Personal injury is found to be extremely unlikely. Based on these findings, the risk of electrical failure from carbon fibers should not prevent the exploitation of composites in aircraft, and additional protection of aircraft avionics to guard aginst carbon fibers is unnecessary. J.M.S.

N80-28443*# Avco Corp., Lowell, Mass. Special Materials Div.
DEVELOPMENT OF A FIRE TEST FACILITY FOR GRAPHITE FIBER-REINFORCED COMPOSITES
J. G. Alexander Jun. 1980 48 p refs
(Contract NAS1-15511)
(NASA-CR-159193) Avail: NTIS HC A03/MF A01 CSCL 11D

A number of modifications were added to the Model 25 facility to make it specifically applicable for composite material screening tests. Most significant was the development of hardware for trapping fibers released during test and isolating them for quantitative measurement. Capability was added for increasing test section velocities and increasing the range of air/fuel ratios available from very rich to very lean. A provision was added for agitation of the test specimen and the combustion gases by a pulsating gas supply. A variety of specimen configurations was evaluated by an extensive series of tests on a graphite-epoxy reference composite which is representative of material currently used in advanced aircraft. A standard test technique and specimen configuration were established which was satisfactory for the reference composite. A test program was then performed on several alternate composite materials to verify the validity of the test method for relative evaluation of a variety of composite materials. R.C.T.

N80-28446*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CARBON FIBER COUNTING
Richard A. Pride Jun. 1980 17 p refs
(NASA-TM-80117) Avail: NTIS HC A02/MF A01 CSCL 11D

A method was developed for characterizing the number and lengths of carbon fibers accidentally released by the burning of composite portions of civil aircraft structure in a jet fuel fire after an accident. Representative samplings of carbon fibers collected on transparent sticky film were counted from photographic enlargements with a computer aided technique which also provided fiber lengths. R.C.T.

N80-28497# Royal Aircraft Establishment, Farnborough (England).
THE DIFFUSION OF WATER VAPOUR IN HUMID AIR INTO THE ADHESIVE LAYER OF BONDED METAL JOINTS
Walter Althof Feb. 1980 71 p refs Transl. into ENGLISH of "Die Diffusion des Wasserdampfes der Feuchten Luft in die Klebschichten von Metallklebungen" DFVLR-FB-79-06 Deutsche forschungs und Versuchsanstalt Fuer Luft und Raumfahrt, West Germany, 1979
(RAE-Lib-Trans-2038; BR74940) Avail: NTIS HC A04/MF A01

The variation of moisture content with time and environment was determined for five aircraft structural adhesives by weighing cured bulk adhesive specimens and laminates before and after extended exposure in six climates. The coefficient of diffusion was calculated according to Fick's theory. The correlation between the moisture content in the adhesive at saturation and the atmospheric humidity was estimated. Several formula were established to calculate the time dependent distribution of moisture in adhesive laminates. Control tests confirmed the applicability of the formula, where the adhesive was not altered by the environment. R.C.T.

N80-28499*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
MATERIALS FOR ADVANCED TURBINE ENGINES. VOLUME 1: POWER METALLURGY RENE 95 ROTATING TURBINE ENGINE PARTS Final Report
W. R. Pfouts, C. E. Shamblen, J. S. Mosier, R. E. Peebles, and R. W. Gorsler Jun. 1979 358 p 2 Vol.
(Contract NAS3-20074)
(NASA-CR-159802; R79AEG416-Vol-1) Avail: NTIS HC A16/MF A01 CSCL 11F

An attempt was made to improve methods for producing powder metallurgy aircraft gas turbine engine parts from the nickel base superalloy known as Rene 95. The parts produced were the high pressure turbine aft shaft for the CF6-50 engine and the stages 5 through 9 compressor disk forgings for the CFM56/F101 engines. A 50% cost reduction was achieved as compared to conventional cast and wrought processing practices. An integrated effort involving several powder producers and a major forging source were included. R.C.T.

N80-28518# Netherlands Organization for Applied Scientific Research TNO, Delft.
FAILURE ANALYSIS
Apeldoorn, Netherlands Metaalinst. TNO 1979 13 p Original contains color illustrations
Avail: NTIS HC A02/MF A01

Brief case histories on metal structures are presented. The following structures are included: an aircraft wheel; an oil storage tank; a drilling platform; a gas turbine; aluminum light standards; and a towbar. Author (ESA)

N80-28539# Crew Systems Consultants, Yellow Springs, Ohio.
FLIGHT TEST RESULTS OF THE USE OF ETHYLENE GLYCOL MONOMETHYL ETHER (EGME) AS AN ANTI-CARBURETOR ICING FUEL ADDITIVE Final Report
Richard L. Newman Jul. 1979 66 p
(Contract DOT-FA78WA-4165)
(AD-A084960; TR-79-9; FAA-AWS-79-1) Avail: NTIS HC A04/MF A01 CSCL 21/4

Flight test results of Ethylene Glycol Monomethyl Ether (EGME) show that EGME reduces the formation of carburetor ice during cruise power, and that the effectiveness of EGME reduces as the throttle is closed. Based on these results, EGME should not be considered as an anti-carburetor icing fuel additive in lieu of carburetor heat. GRA

N80-28550# Chevron Research Co., Richmond, Calif.
REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES Quarterly Report, Apr. - Jun. 1979
R. F. Sullivan and D. J. Rear Jul. 1979 79 p
(Contract EX-76-C-01-2315)
(FE-2315-40) Avail: NTIS HC A05/MF A01

Pilot plant results for a two stage hydrocracker are presented. It is shown that H-coal whole process product can be hydrotreated to make a jet fuel similar to the jet fuel from SRC-2 whole process product. DOE

N80-28712 Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de l'Energitique.
EXTENSION OF THE OPERATING RANGE OF A HIGH COMPRESSION RATIO CENTRIFUGAL COMPRESSOR Final Report [ELARGISSEMENT DU DOMAINE DE FONCTIONNEMENT D'UN COMPRESSEUR CENTRIFUGE A TAUX DE COMPRESSION ELEVE]
Yves Ribaud Aug. 1979 76 p refs In FRENCH
(Contract DGRST-76-7-0590)
Avail: Issuing Activity

The performance and behavior of a heavy gas compressor of simple technological design were investigated. An existing compressor with a compression ratio of 8 was converted into a compressor with an extended operating range with a compression ratio of 4. It was not possible to significantly improve the performance of the compressor. Basic calculations are given for the development of a compressor capable of fulfilling the required objectives (wide operating range, high performance).
Author (ESA)

N80-28725# Shaker Research Corp., Ballston Lake, N. Y.
ROTOR-BEARING DYNAMICS TECHNOLOGY DESIGN GUIDE. PART 5: DYNAMIC ANALYSIS OF INCOMPRESSIBLE FLUID BEARINGS Interim Report, 15 Sep. 1977 - 15 Jan. 1978
Paul E. Allaire, John C. Nicholas, Edgar J. Gunter, and Coda H. T. Pan Wright-Patterson AFB, Ohio AFAPL Mar. 1980 95 p refs
(Contract F33615-76-C-2038; AF Proj. 3048)
(AD-A085106; SRC-78-TR-35-Pt-5; AFAPL-TR-78-6-Pt-5)
Avail: NTIS HC A05/MF A01 CSCL 13/9

This report gives the equilibrium position, bearing coefficients, friction torque, and oil flow for plain journal, multilobe, and tilting pad journal bearings. For multilobe bearings, various combinations of preload, number of pads, and load direction are evaluated. Tilting pad bearings are analyzed for various combinations of length to diameter ratio, preload, number of pads, and load direction. GRA

N80-28943*# National Aeronautics and Space Administration, Washington, D. C.
DISTURBANCE CAUSED BY AIRCRAFT NOISE
R. Josse Apr. 1980 14 p Transl. into ENGLISH from Cah. du Centre Sci. et Tech. du Batiment (Paris), Rept. 100, Cah. 689, Jun. 1969 p 46-51 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-3199)
(NASA-TM-75474) Avail: NTIS HC A02/MF A01 CSCL 13B

Noise pollution caused by the presence of airfields adjacent to residential areas is studied. Noise effects on the sleep of residents near airports and the degree of the residents noise tolerance are evaluated. What aircraft noises are annoying and to what extent the annoyance varies with sound level are discussed. L.F.M.

N80-28944*# National Aeronautics and Space Administration, Washington, D. C.
REACTION OF THE FRENCH POPULATION TO THE SUPERSONIC BANG
J. Bremond May 1980 16 p Transl. into ENGLISH from Rev. Med. Aeronaut. et Spatiale (France), v. 13, no. 51, 1974 p 208-213 Original language document announced as A75-17371 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prepared by French Army Research Div.
(Contract NASw-3199)
(NASA-TM-75487) Avail: NTIS HC A02/MF A01 CSCL 13B

A discussion of a survey dealing with the supersonic bang is presented. Topics include the position the bang has in today's pollution, annoyance caused by the bang and its dependence on sociological and psychological variables, and whether or not the perception of the ban is objective. Other questions raised are whether the frequency of exposure to the bang has an influence on attitudes and does the sensitivity to or annoyance from the bang have a linear increase with the frequency. E.D.K.

N80-28946*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ANNOYANCE DUE TO MULTIPLE AIRPLANE NOISE EXPOSURE
Clemans A. Powell Aug. 1980 42 p refs
(NASA-TP-1706; L-13710) Avail: NTIS HC A03/MF A01 CSCL 13B

A laboratory study was conducted to investigate the annoyance effects of multiple aircraft noise exposure in which 250 subjects judged the annoyance of half-hour periods of airplane noise simulative of typical indoor home exposures. The variables of the aircraft noise exposure were the peak noise level of flyovers, which was constant within each period, and the number of flyovers. Each subject judged 5 of the possible 25 factorial combinations of level and number. Other variables investigated included the experience of the test subjects in making annoyance judgments and their home exposure to airplane noise. The annoyance judgments increased with both noise level and number of flyovers. The increased annoyance produced by doubling the number of flyovers was found to be the equivalent of a 4 to 6 db increase in noise level. The sensitivity of the subjects to changes in both noise level and number of flyovers increased with laboratory experience. Although the means of the annoyance judgments made in the laboratory were found to decrease with the subjects' home exposure to aircraft noise, the subjects' sensitivities to changes in both level and number were unaffected by their home exposure. Author

N80-28952# Institut de Recherche de Transports, Bron (France). Centre d'Evaluation et de Recherches des Nuisances.
POLLUTION BY AIRCRAFT TRAFFIC. POLLUTION FORECAST MODEL IN THE VICINITY OF AIRPORTS. APPLICATION TO VARIOUS AIRPORTS: ORLY AND ROISSY-EN-FRANCE
Jean Delsey, Robert Joumard, and Gerard Peri (Societe Comex, Marseille, France) 1979 14 p refs
Avail: NTIS HC A02/MF A01

The differential equation of pollutant turbulent diffusion is numerically resolved for airports after some simplifications. The hypotheses which led to wind and diffusivity formulas are indicated. Data are given for calculating the different parameters, particularly those of aircraft pollutant emissions depending on different types of aircraft. The model is operational for any airport and shows the importance of meteorological factors.
Author (ESA)

N80-29065# National Technical Information Service, Springfield, Va.
AEROSPACE COMPUTER SYSTEMS: AVIONICS APPLICATIONS. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1978 - Mar. 1980
Brian Carrigan May 1980 154 p Supersedes NTIS/PS-79/0313; NTIS/PS-78/0289
(PB80-810179; NTIS/PS-79/0313; NTIS/PS-78/0289) Avail: NTIS HC $30.00/MF $30.00 CSCL 09B

Studies of computer hardware and supporting software for aircraft applications are cited. The bibliography includes research on onboard data processing equipment as well as navigation and guidance computers. This updated bibliography contains 147 abstracts, 56 of which are new entries to the previous edition. GRA

N80-29095*# DyTec Engineering, Inc., Long Beach, Calif.
ATMOSPHERIC TURBULENCE EFFECTS ON AIRCRAFT NOISE PROPAGATION
Robert L. Chapkis Jun. 1979 55 p refs
(Contract NAS1-15321)
(NASA-CR-159325; DyTec-7924) Avail: NTIS HC A04/MF A01 CSCL 20A

The Brown and Clifford model for the apparent sound attenuation cuased by atmospheric turbulence was reviewed and extended. Calculations, based on the model, were made for the predicted sound attenuation for a tower-mounted loudspeaker-type sound source and for an airplane sound source. The important parameters in the model are identified and discussed. A model for sound fluctuations is also presented and a practical experimental program to validate the models described. A.R.H.

N80-29204# Naval Postgraduate School, Monterey, Calif.
ON-LINE REAL-TIME MANAGEMENT INFORMATION SYSTEMS AND THEIR IMPACT UPON USER PERSONNEL AND ORGANIZATIONAL STRUCTURE IN AVIATION MAINTENANCE ACTIVITIES M.S. Thesis
Benjamin A. Bayma, Jr. Dec. 1979 97 p refs
(AD-A085111) Avail: NTIS HC A05/MF A01 CSCL 15/7

The introduction of a new technology into an organization can significantly impact the organization's effectiveness. Some possible effects on user personnel and organizational structure during and after the implementation of an on-line real-time computer-based management information system are explored in this thesis. The organizational structure and Management Information Service (MIS) users within aviation maintenance activities are identified. The possible impact on the informal and formal decision-making structures within these activities is predicted using a contingency model. Possible implementation strategies to minimize that impact and maximize the probability of MIS implementation success are investigated. The Naval Aviation Logistics Command Management Information System (NALCOMIS) is used as a vehicle to predict possible implementation impacts and strategies. The NALCOMIS Project Manager and his staff are provided with a partial list of possible problems areas to be aware of during NALCOMIS implementation. GRA

N80-29244*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CONTROL-SYSTEM TECHNIQUES FOR IMPROVED DEPARTURE/SPIN RESISTANCE FOR FIGHTER AIRCRAFT
Luat T. Nguyen, William P. Gilbert, and Marilyn E. Ogburn Aug. 1980 69 p refs
(NASA-TP-1689; L-13453) Avail: NTIS HC A04/MF A01 CSCL 01C

Some fundamental information on control system effects on controllability of highly maneuverable aircraft at high angles of attack are summarized as well as techniques for enhancing fighter aircraft departure/spin resistance using control system design. The discussion includes: (1) a brief review of pertinent high angle of attack phenomena including aerodynamics, inertia coupling, and kinematic coupling; (2) effects of conventional stability augmentation systems at high angles of attack; (3) high angle of attack control system concepts designed to enhance departure/spin resistance; and (4) the outlook for applications of these concepts to future fighters, particularly those designs which incorporate relaxed static stability. R.C.T.

N80-29245*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUBSONIC AIRCRAFT: EVOLUTION AND THE MATCHING OF SIZE TO PERFORMANCE
Laurence K. Loftin, Jr. Aug. 1980 445 p refs
(NASA-RP-1060; L-13367) Avail: NTIS HC A19/MF A01 CSCL 01B

Methods for estimating the approximate size, weight, and power of aircraft intended to meet specified performance requirements are presented for both jet-powered and propeller-driven aircraft. The methods are simple and require only the use of a pocket computer for rapid application to specific sizing problems. Application of the methods is illustrated by means of sizing studies of a series of jet-powered and propeller-driven aircraft with varying design constraints. Some aspects of the

technical evolution of the airplane from 1918 to the present are also briefly discussed. Author

N80-29246# CACI, Inc. - Federal, Arlington, Va.
AVIATION COMPONENT REPAIR PROGRAM ANALYSIS, VOLUME 1 Final Report
Mar. 1980 65 p
(Contract N00014-80-C-0097)
(AD-A086060) Avail: NTIS HC A04/MF A01 CSCL 15/5

Depot repair of aviation repairable components supports the flight operations of the U.S. Navy and Naval Reserve Aircraft. In order to determine an appropriate measure of effectiveness which could be used to assess the impact of the component repair program., several statistical analyses were performed comparing financial and other data related to the Aviation Component Repair Program, data in aviation related programs and various effectiveness measures. GRA

N80-29247# Cost Analysis Improvement Group, Washington, D.C.
AIRCRAFT OPERATING AND SUPPORT COST DEVELOPMENT GUIDE
15 Apr. 1980 23 p
(AD-A085854) Avail: NTIS HC A02/MF A01 CSCL 14/1

This document provides guidelines for preparing and presenting estimates of operating and support (O S) costs to the OSD Cost Analysis Improvement Group (CAIG) and the Defense Systems Acquisition Review Council (DSARC). These guidelines are intended to achieve consistent and effective preparation and documentation of major system O S cost estimates. This guide updates and expands the CAIG 'Cost Development Guide for Aircraft Systems' originally published in May 1974. GRA

N80-29249*# Grumman Aerospace Corp., Bethpage, N.Y.
TOWARDS COMPLETE CONFIGURATIONS USING AN EMBEDDED GRID APPROACH Final Report
Charles W. Boppe Washington, D.C. Jul. 1978 19 p refs
(Contract NAS1-14732)
(NASA-CR-3030) Avail: NTIS HC A02/MF A01 CSCL 01A

A new approach to simulating transonic flow about transport configurations is briefly outlined. The methods embedded grid scheme provides a high degree of computational resolution coupled with geometric flexibility for future applications to complex shapes. Calculations presented illustrate aspects of transonic transport design including fuselage design, determination of wing control surface deflection effectiveness, and wing design. Author

N80-29252# Army Research and Technology Labs., Moffett Field, Calif.
DYNAMIC STALL ON ADVANCED AIRFOIL SECTIONS
W. J. McCroskey, K. W. McAlister, L. W. Carr, S. L. Pucci, O. Lambert (Service Technique des Construction Aeronautiques, Paris), and R. F. Indergand (Mather AFB, Calif.) May 1980 26 p refs Presented at the 36th Annual Forum of the Am. Helicopter Soc., Washington, D.C., May 1980
(AD-A085809) Avail: NTIS HC A03/MF A01 CSCL 01/2

The dynamic stall characteristics of eight airfoils have been investigated in sinusoidal pitch oscillations over a wide range of two dimensional unsteady flow conditions. The results provide a unique comparison of the effects of section geometry in a simulated rotor environment. Important differences between the various airfoils were observed, particularly when the stall regimes were penetrated only slightly. Under these circumstances, the profiles that stall gradually from the trailing edge appear to offer an advantage. However, all of the airfoils tended increasingly toward leading-edge stall when both the severity of dynamic stall and the free-stream Mach number increased. In all cases, the parameters of the unsteady motion appear to be more important than airfoil geometry for configurations that are appropriate for helicopter rotors. GRA

N80-29253*# Aerospace Systems, Inc., Burlington, Mass.
STEADY, OSCILLATORY, AND UNSTEADY SUBSONIC AERODYNAMICS, PRODUCTION VERSION 1.1 (SOUSSA-P 1.1). VOLUME 2: USER/PROGRAMMER MANUAL
Scott A. Smolka, Robert D. Preuss, Kadin Tseng, and Luigi Morino Jun. 1980 184 p refs
(Contract NAS1-14977)
(NASA-CR-159131) HC A09/MF A01 CSCL 01A

A user/programmer manual for the computer program SOUSSA P 1.1 is presented. The program was designed to provide accurate and efficient evaluation of steady and unsteady loads on aircraft having arbitarary shapes and motions, including structural deformations. These design goals were in part achieved through the incorporation of the data handling capabilities of the SPAR finite element Structural Analysis computer program. As a further result, SOUSSA P possesses an extensive check-point/ restart facility. The programmer's portion of this manual includes overlay/subroutine hierarchy, logical flow of control, definition of SOUSSA P 1.1 FORTRAN variables, and definition of SOUSSA P 1.1 subroutines. Purpose of the SOUSSA P 1.1 modules, input data to the program, output of the program, hardware/software requirements, error detection and reporting capabilities, job control statements, a summary of the procedure for running the program and two test cases including input and output and listings are described in the user oriented portion of the manual. R.K.G.

N80-29254*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A COMPUTER PROGRAM FOR THE DESIGN AND ANALYSIS OF LOW-SPEED AIRFOILS
Richard Eppler (Stuttgart Univ., West Germany) and Dan M. Somers Aug. 1980 145 p refs
(NASA-TM-80210; L-12937) Avail: NTIS HC A07/MF A01 CSCL 01A

A conformal mapping method for the design of airfoils with prescribed velocity distribution characteristics, a panel method for the analysis of the potential flow about given airfoils, and a boundary layer method have been combined. With this combined method, airfoils with prescribed boundary layer characteristics can be designed and airfoils with prescribed shapes can be analyzed. All three methods are described briefly. The program and its input options are described. A complete listing is given as an appendix. Author

N80-29255*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ANALYSIS OF TRANSONIC SWEPT WINGS USING ASYMPTOTIC AND OTHER NUMERICAL METHODS
H. K. Cheng, S. Y. Meng, R. Chow (Grumman Aerospace Corp., Bethpage, N.Y.), and R. Smith May 1980 31 p refs Presented at the 18th AIAA Aerospace Sci. Meeting, Pasadena, Calif., 14-16 Jan. 1980 Prepared in cooperation with Univ. of Southern California, Los Angeles
(Contract N00014-75-C-0520; NR Proj. 061-192)
(NASA-TM-80762; AD-A085587; USCAE-138) Avail: NTIS HC A03/MF A01 CSCL 20/4

Asymptotic theories for high-aspect-ratio wings in transonic flow developed recently show that the three dimensional (3-D) mixed-flow calculations may be reduced to solving a set of 2-D problems at each span station. For wings with surfaces generated from a single airfoil shape, local similutude exists in the 3-D flow structure, permitting the problems to be solved once for all span stations. This paper reviews this theoretical development. The essential elements in the theory will be identified. Their relationship to the lifting-line theory and related classical methods are discussed. Examples of similarity solutions are demonstrated for high subcritical and slightly super-critical component flows; comparisons with relaxation solutions to a full potential equation are made. The study also examines the adequacy of the existing full-potential computer code. Outstanding problems remaining for subsequent development are discussed. GRA

N80-29256# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DEVELOPMENT AND APPLICATION OF A SUBSONIC TRIANGULAR VORTEX PANEL M.S. Thesis
John C. Sparks Jun. 1980 86 p refs

(AD-A085595; AFIT/GAE/AE/80J-1) Avail: NTIS HC A05/MF A01 CSCL 20/4

Paneling methods are approximate techniques for solving flow problems over wings and bodies. Vortex panels are used to model flow over wings and other lifting surfaces. The author develops a triangular vortex panel having a vorticity distribution that can vary in magnitude and direction. This panel is used to predict the pressure distribution on a rectangular and a sweptback wing in subsonic flow. Lift distributions obtained compare favorably to Anderson's solution and wind tunnel results except near the wing tip. In this region, the distribution will spike before satisfying the Kutta condition imposed at the tip. Possible remedies for the tip problem are discussed. GRA

N80-29257# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio. Ramjet Engineering Div.

CALCULATION TECHNIQUES FOR INVISCID TWO-DIMENSIONAL SUPERSONIC AIRFLOW Final Report, Sep. 1977 - Dec. 1978

M. Brian Bergsten Sep. 1979 135 p refs

(AF Proj. 3012)

(AD-A085327; AFAPL-TR-79-2023) Avail: NTIS HC A07/MF A01 CSCL 20/4

Techniques for calculating the change in properties of inviscid supersonic airflow passing over or through various two dimensional bodies are discussed in this report. Low supersonic (M less than 4) airflows and high supersonic (M greater than 4) airflows are considered separately. Flow phenomena considered include normal shock waves, oblique shock waves, insentropic expansions, and conical shock waves for cones at zero degrees angle of attack. The adjustments required for swept wings are also discussed. Printouts of computer subroutines designed to carry out the described calculation procedures are included in an appendix to the report. Examples describing the use of the calculation techniques and computer subroutines for a swept wing, and for two typical ramjet inlets are included. A final appendix includes charts that can be used as calculation aids for airflows at Mach numbers up to 4. GRA

N80-29259# Transportation Systems Center, Cambridge, Mass.

GROUND WIND VORTEX SENSING SYSTEM CALIBRATION TESTS Final Report, Apr. 1971 - Nov. 1972

T. E. Sullivan and D. C. Burnham Feb. 1980 85 p refs

(AD-A085647; TSR-FAA-80-4; FAA-RD-80-13) Avail: NTIS HC A05/MF A01 CSCL 14/2

This report describes the collection of data related to the calibration of two systems for detecting and tracking aircraft wake vortices. The systems tested were the propeller anemometer Ground Wind Vortex Sensing System and the Pulsed Acoustic Vortex Sensing System. The data were analyzed and the location of the vortices as determined with these systems were compared with the vortex location as determined photographically. The tests were conducted at the Federal Aviation Administration's National Aviation Facilities Experimental Center, in Atlantic City, N. J. GRA

N80-29262# Vereinigte Flugtechnische Werke-Fokker G.m.b.H., Bremen (West Germany).

TRANSONIC AIRFOILS: THE DESIGN OF A SUPERCRITICAL WING FOR TRANSPORT AIRCRAFT Final Report, Oct. 1978

Guenter Krenz Bonn Bundesmin. fuer Forsch. u. Technol. Oct. 1979 85 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-W-79-11; PR-2) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 17,45

As part of the Airbus A 300 B10 (A310) development program, the design and wind tunnel characterization of four supercritical wings in a transonic flow are reported on. Wind tunnel measurements made on airfoil profiles are analyzed. Results are used in the choice of a wing configuration for a full scale model to be subjected to further transonic wind tunnel tests. Model construction and data collection schemes are discussed. Transonic flow theory is also considered. At present, the influence of the engine assembly on the wing configuration and its flow field has yet to be satisfactorily calculated. Author (ESA)

N80-29263# Aeronautical Research Labs., Melbourne (Australia).

THE STRENGTH OF OCCUPANT RESTRAINT SYSTEM IN LIGHT AIRCRAFT: AN EXPERIMENTAL EVALUATION

S. R. Sarrailhe Feb. 1979 40 p

(ARL-Struc-Rept-375; AR-001-600) Avail: NTIS HC A03/MF A01

The cabins and restraint systems of three cyclone-damaged light aircraft were tested statically to determine the strength of the restraint system in the cabin. It was found that most restraining components were much stronger than demanded by the 9 g requirement and it was considered that only minor improvements would be needed to ensure 25 g capability. Seats were not as strong as the restraints and their behavior under crash load conditions requires further investigation. Author

N80-29264# Federal Aviation Administration, Washington, D. C.

FIRST COMMUTER AIR CARRIER SAFETY SYMPOSIUM

Jan. 1980 253 p Symp. held at Washington, D.C., 16-17 Jan. 1980

(AD-A085628) Avail: NTIS HC A12/MF A01 CSCL 01/2

This is the first commuter air carrier safety symposium held by the FAA. The objective is to review the significant problems which are inseparable from safety issues. Most of the accidents which have occurred in the last several years have involved recurring contributing factors, in operations, maintenance, and training, and most are truly avoidable. The program is directed toward a listening session and regulatory overview; the industry presented its perspectives with reliability, and air-worthiness; human factors considerations in accident prevention; and the prospects of, or needs for, airport and airway development for commuter service. GRA

N80-29265# Battelle Columbus Labs., Ohio.

EVALUATION OF SAFETY PROGRAMS WITH RESPECT TO THE CAUSES OF AIR CARRIER ACCIDENTS

T. M. Connor and C. W. Hamilton Jan. 1980 257 p refs

(Contract DOT-FA77WA-4072)

(AD-A085347; FAA-ASP-80-1) Avail: NTIS HC A12/MF A01 CSCL 13/12

The objective of this study was to determine the extent to which the FAA safety programs were aligned with the causes of air carrier accidents. The data base used in this study consisted of a total of 760 air carrier accident records compiled by the National Transportation Safety Board (NTSB) from 1966 through 1975. Analysis of these records was made with respect to NTSB-cited cause/factors. FAA programs implemented during the study time period and pertaining to safety were also included in this study. Conclusions of this study are: (1) no substantive change is required with respect to mechanical safety programs, (2) broader investigation into the integration of environmental programs with human factors programs is required, (3) new program initiatives addressing human error problems in behavior terms are required. GRA

N80-29266# Federal Aviation Administration, Washington, D. C. Office of Aviation Medicine.

THE CURRENT ROLE OF ALCOHOL AS A FACTOR IN CIVIL AIRCRAFT ACCIDENTS

Leonard C. Ryan and Stanley R. Mohler (Wright State Univ.) May 1980 13 p refs

(AD-A086261; FAA-AM-80-4) Avail: NTIS HC A02/MF A01 CSCL 01/2

Ethyl alcohol continues as a serious adverse factor in general aviation flight safety. According to FAA figures, the level of alcohol-associated general aviation fatal accidents has remained relatively static at a 16% general level since 1969. A recent survey of the attitudes of pilots toward alcohol and flying reveals a lack of appreciation among one-third of the pilots concerning the adverse effects of alcohol and safe flight. A renewed pilot education program on alcohol and flight safety appears indicated. GRA

N80-29267# Federal Aviation Administration, Washington, D. C. Office of Systems Engineering Management.

ACTIVE BCAS PERFORMANCE IN A GARBLE ENVIRONMENT

Edmund J. Koenke 24 Jan. 1980 50 p refs
(AD-A086046; FAA-EM-80-1) Avail: NTIS HC A03/MF A01 CSCL 01/2

A basic design tool has been developed which includes the principal BCAS design parameters, namely, transmitter power, receiver sensitivity, aircraft density, closure rate, degarble capability, and interrogation rate. This tool can be directly applied to the evaluation of alternative BCAS design concepts as well as for parametric design studies. Results of a comparison between an ATCRBS/DABS BCAS and an ATCRBS only BCAS are presented leaving little doubt concerning the performance advantage offered by the inclusion of the DABS link for evasive maneuver coordination. It must be emphasized that neither of the BCAS systems analyzed in this report are representative of the accitive BCAS defined in the draft National Standard for active BCAS. GRA

N80-29268# Ultrasystems, Inc., Irvine, Calif.
FLUID CONTAMINATION OF AIRCRAFT-CABIN AIR AND BREATHING OXYGEN Final Report, 19 Jun. 1978 - 19 Jun. 1979
K. L. Paciorek, J. H. Nakahara, and R. H. Kratzer Dec. 1979 53 p
(Contract F33615-78-C-0612; AF Proj. 7930)
(AD-A085818; SN-8331-F; SAM-TR-79-34) Avail: NTIS HC A04/MF A01 CSCL 01/3

From different manufacturers, a series of lubricating oils (MIL-L-7808), hydraulic fluids (MIL-H-5606), and heat-transfer fluids (MIL-C-47220) were obtained to test their potential for contaminating aircraft breathing air and oxygen. No significant differences were detectable in the compositions of lubricating oils and hydraulic fluids, irrespective of the origin, including fluids recovered after service in an aircraft. The two heat-transfer fluids of interest were single compounds. Under normal operating conditions, the hydraulic and heat-transfer fluids afforded minimal quantities of products. The lubricating oils volatized to a large degree; the mists consisted essentially of unchanged starting materials. Tests simulating line rupture with fluid spilling onto a hot, 450 C (850 F), metal surface in the presence of air resulted in excessive fluid degradiation. In all instances, significant quantities of hydrocarbons, carbonyls, and alcohols were produced. Among these, the highly toxic formaldehyde, acrolein, formic acid, and formates were found and quantitated. GRA

N80-29269# ECON, Inc., Princeton, N. J.
THE ALLOCATION OF RUNWAY SLOTS BY AUCTION. VOLUME 1: EXECUTIVE SUMMARY Final Report
F. M. Sand and M. L. Balinski 15 Apr. 1980 50 p refs 3 Vol.
(Contract DOT-FA79WA-4374)
(AD-A085739; FAA-AVP-80-3-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 01/2

The allocation of runway slots at the high-density airports by means of an auction is studied. Previous approaches to slot auctions have not allowed for the interdependency of slot values to the air carriers: a single slot for a landing of an aircraft is likely to be of little value without a corresponding slot for a subsequent take-off of that aircraft. A Slot Exchange Auction is designed, its theoretical properties and practical implementation discussed. It is shown to allow the slot market to reach an efficient equilibrium under competitive conditions. The Airline Management Game is used to create a simulation test of the Slot Exchange Auction and its associated continuous market, the slot exchange. GRA

N80-29270# ECON, Inc., Princeton, N. J.
THE ALLOCATION OF RUNWAY SLOTS BY AUCTION. VOLUME 2: THE AIRLINE MANAGEMENT GAME AND SLOT AUCTION TESTING Final Report
F. M. Sand and M. L. Balinski Apr. 1980 178 p refs Prepared in cooperation with Flight Transportation Associates, Cambridge, Mass. 3 Vol.
(Contract DOT-FA79WA-4374)
(AD-A085438; FAA-AVP-80-3-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 01/2

A specific mechanism for allocating slots between competing air carriers based on a sequential auction procedure is analyzed. The mechanism is shown to achieve an efficient slot solution where one exists. In case there is no efficient solution, it is proposed that the slot market remain open continuously throughout the six months of operations so that air carriers can exchange slots on the open slot market in order to improve the balance between slot allocations and flight schedules. The continuous slot exchange has the additional advantage that it allows changes in the allocation of scarce runway capacity in response to changing economic and air transportation conditions. J.M.S.

N80-29271# ECON, Inc., Princeton, N. J.
THE ALLOCATION OF RUNWAY SLOTS BY AUCTION. VOLUME 3: THEORY AND TECHNICAL ISSUES FOR IMPLEMENTATION Final Report
F. M. Sand and M. L. Balinski Apr. 1980 87 p refs 3 Vol.
(Contract DOT-FA79WA-4374)
(AD-A085455; AVP-80-3-Vol-3) Avail: NTIS HC A05/MF A01 CSCL 01/2

In order to evaluate the viability of the slot exchange auction and subsequent continuous slot exchange, an interactive computer simulation of actual slot auctions was conducted using the Airline Management Game. The scenario included 5 competing airlines and 17 airports with 3 of them being capacity-limited. Hourly quotes for the airports were established based on the airport activity profiles obtained in the base case. The participants were instructed to maximize short-run airline profits using a fixed fleet of aircraft and fixed fares, but free choice of routes and schedules. The schedules were assumed to operate for six months at a time. The Airline Management Game is outlined, and the experimental design, the bidding rules, and the results and analyses of the evaluation exercise are included. The testing of the slot allocation methods is demonstrated. The test was inconclusive in regard to convergence to equilibrium and the economic efficiency and equitability of the slot exchange method. J.M.S.

N80-29272# Air Force Environmental Technical Applications Center, Scott AFB, Ill.
WIND FACTOR SIMULATION MODEL: USER'S MANUAL Final Report
Roger C. Whiton and Patrick L. Herod Apr. 1980 66 p
(AD-A085486; USAFETAC/TN-80/002) Avail: NTIS HC A04/MF A01 CSCL 09/2

User instructions and a concise description are provided for a Wind Factor Simulation Model (WFSM). The WFSM is a fast, economical module designed to reside as a collection of subroutines within the user's larger simulation model. The WFSM, upon call by the user, produces mean overall climatological wind factors for great circle routes between arbitrary man overall climatological wind factors for great circle routes between arbitrary points 'A' and 'B' (specified by latitude and longitude) anywhere on the globe. The WFSM produces wind factors in any of three modes (calm wind case, 90 percent worst case, and the mean wind case), for either of two altitudes (25,000 ft and 35, 000 ft) for any of four seasons of the year. In addition, the model can provide great circle distance between points 'A' and 'B'. From this information and known airspeed, the user can calculate ground speed and adjusted flying time between 'A' and 'B'. Software solves the equation of a great circle. Program listing and flow chart are included. GRA

N80-29273# Federal Aviation Administration, Washington, D. C. Systems Research and Development Service.
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE REPORT OF R AND D ACTIVITY
Nathan Aronson, Gary R. Rowland, Donald L. Scheffler, James P. Dugan, and Parker E. Harris, Jr. May 1980 189 p refs
(AD-A085629; FAA-RD-80-54) Avail: NTIS HC A09/MF A01 CSCL 17/7

Recent achievements and results expected in the near future are discussed in 26 technical papers covering the following areas: terminal information processing; metering and spacing for automated radar terminal systems; electronic tabular display systems; en route minimum safe attitude warning function

integrated with the current NASA automation system; en route display recording/playback; airport surface detection equipment surveillance radar; digital radar for air traffic control terminal areas; discrete address beacon system link applications; moving target detectors; automatic traffic advisory and resolution service; beacon collision avoidance system; airport security systems: bomb and explosives detection; air transport cockpit alerts/warning systems; helicopter development program; LORAN-C development; wind shear program; head-up displays for civil aviation; systems characterizing thunderstorms for safe aircraft operations; automation of aviation weather observations; computer generated voice response; automated route forecasts; and the FAA remote terminal system frequency assignment model. A.R.H.

N80-29274# Air Force Environmental Technical Applications Center, Scott AFB, Ill.

WIND FACTOR SIMULATION MODEL: MODEL DESCRIPTION Final Report

Roger C. Whiton and Patrick L. Herod Apr. 1980 38 p refs (AD-A085733; USAFETAC/TN-80/001) Avail: NTIS HC A03/MF A01 CSCL 17/7

A simplified, small and efficient Wind Factor Simulation (WFSM) is developed for inclusion in a Military Airlift Command (MAC) airlift system simulation called COLOSSUS. The WFSM calculates climatological wind factors by Sawyer's equivalent headwind technique for arbitrary great circle routes at specified altitudes for any of four seasons in any of three wind options. This technique is combined with the mathematics of great circle navigation in a constellation of seven FORTRAN subprograms. in the WFSM, a simulated aircraft is navigated along a great circle route between any two points on the globe. Involved in the mathematics of the navigation is solving the equation of a great circle. This equation is sometimes transcendental. In those cases, Newton's iterative method for the solution of nonlinear algebraic equations is used. The WFSM also calculates the great circle distance in nautical miles and the initial heading in degrees of any two points whose latitude and longitude are known. GRA

N80-29275# Westinghouse Electric Corp., Baltimore, Md.

FAR FIELD MONITOR FOR INSTRUMENT LANDING SYSTEMS, PHASES 1 AND 2 Interim Report

R. More, J. C. Bradley, and B. Newman Nov. 1979 318 p refs

(Contract DOT-FA75WA-3689)

(AD-A079663; FAA-RD-79-7023) Avail: NTIS HC A14/MF A01 CSCL 17/7

This report describes a study performed to determine the nature of scattering of ILS radiated signals by objects on the airport property. These included both taxiing and overflying aircraft. The interaction of this scattered energy with the direct radiation was studied to determine the derogating effects of ILS guidance. This resulted in the development of four system level concepts for detecting glide path derogation. One technique, the Vector DDM, was selected as being most practical from a sensitivity, reliability, and cost point-of-view. GRA

N80-29276# National Aviation Facilities Experimental Center, Atlantic City, N. J.

DISCRETE ADDRESS BEACON SYSTEM (DABS) BASELINE TEST AND EVALUATION Interim Report, Jun. - Sep. 1979

M. Holtz, W. Swanseen, M. Karlin, R. Spadea, and D. Fisher Apr. 1980 142 p refs

(FAA Proj. 034-241-510)

(AD-A085585; FAA-NA-79-52; FAA-RD-80-36) Avail: NTIS HC A07/MF A01 CSCL 17/7

Tests and evaluation (T E) were conducted principally to determine baseline performance characteristics of the Discrete Address Beacon System (DABS) sensor employing the software and associated parameter values as delivered by Texas Instruments (TI), Incorporated in June 1979. A secondary objective was to highlight those areas where changes in system parameters, made necessary by the maturing of the DABS/Automatic Traffic Advisory and Resolution Service (ATARS) system concept, would require further study and test prior to issuance of the Technical Data Package (TDP). Simulation techniques, targets of opportunity, and DABS transponder-equipped aircraft were used. The DABS sensor test program was accomplished with an Air Traffic Control Radar Beacon System (ATCRBS) 5 foot antenna having a 2.4 deg beam width, and the DABS sensor transmitter power output and effective beam width values as delivered by the contractor. Data reduction and analysis tools developed by the National Aviation Facilities Experimental Center (NAFEC) were used to determine sensor performance characteristics and to highlight areas for further analysis. It was concluded that, with few exceptions, the DABS engineering model in the implementation tested performed in compliance with or exceeded the requirements as defined in the DABS Engineering Requirements (FAA-ER-240-26). Those exceptions are discussed in the body of the report along with recommendations for further activity. GRA

N80-29279# Performance Measurement Associates, Inc., Vienna, Va.

DATA ANALYSIS METHODOLOGY FOR DAY/NIGHT INFLIGHT TACTICAL NAVIGATION Final Report, 8 Aug. 1977 - 19 Mar. 1979

Edward M. Connelly and Robert F. Comeau Sep. 1979 127 p (Contract DAHC19-77-C-0042; DA Proj. 2Q2-63743-A-772) (AD-A082731; PMA-7-79; ARI-TR-411) Avail: NTIS HC A07/MF A01 CSCL 17/7

Low-level helicopter navigation, both at night and during the day, is an essential portion of the Army's mission. Navigation performance, defined as the probability of navigating along a prescribed route or route segment without deviation, is a function of many factors including map type, terrain type, and time of day. Determining the effects of these factors is important for predicting performance of Army navigators, identifying factors critical to navigation, evaluating the probability of navigation success along a route, and developing training aids. The research reported here analyzed low-level flight experiment data to develop that information. This report contains results of the analyses of helicopter low-level navigation data, (a) to determine the probability of navigation success along a route as a function of terrain type, (b) to develop a means of determining route difficulty, and (c) to develop a method of scoring student performance. The FORTRAN computer programs and the navigation data base used in the analysis are also documented. GRA

N80-29280# National Aviation Facilities Experimental Center, Atlantic City, N. J.

TEST AND EVALUATION OF THE AIRPORT SURVEILLANCE RADAR (ASR)-8 WIND SHEAR DETECTION SYSTEM, PHASE 2 Interim Report, Apr. - Dec. 1979

D. L. Offi, W. Lewis, T. Lee, and A. DeLaMarche May 1980 41 p refs

(AD-A086045; FAA-NA-80-17; FAA-RD-80-21) Avail: NTIS HC A03/MF A01 CSCL 17/9

A wind shear detection system developed by the Wave Propagation Laboratory to operate with the Federal Aviation Administration (FAA) Airport Surveillance Radar (ASR)-8 was installed and is being tested at the FAA Technical Center. Second phase tests compared radar with aircraft and tower winds, evaluated the wind shear measurement capability under various weather conditions, and investigated the effectiveness of a simple two azimuth pointing strategy and system capabilities and limitations. Results showed the system to be compatible with and to operate satisfactorily with the ASR-8. The processing and spectral display of clear air and precipitation returns is feasible. The accuracy of agreement between radar-measured winds and components of the aircraft-measured winds in both radially oriented flights and runway offset flights, using a two azimuth pointing technique, was examined. Radar versus tower wind agreement was also examined. Potentially dangerous wind shears associated with weather during these tests were detectable. Certain system limitations also have been defined and considered. It is recommended that tests continue to complete definition of and demonstrate capabilities in all weather situations. GRA

N80-29281# Transportation Systems Center, Cambridge, Mass.

INTERFERENCE AND NOISE IN AND ADJACENT TO THE LORAN-C SPECTRUM AT AIRPORTS Final Report, Sep. - Dec. 1979

Peter G. Mauro May 1980 96 p refs Prepared for FAA, Washington, D.C.
(AD-A086043; TSC-FAA-80-8; FAA-RD-80-53) Avail: NTIS HC A05/MF A01 CSCL 17/7

Electrical noise and interference in the LORAN-C frequency band was measured at two rural airports in Vermont and a major airport in Boston, Mass. The purpose of the test program was to determine the potential interfering sources that could affect the proper operation of the radio navigational system, LORAN-C, when it is used for non-precision approaches and terminal and en route navigation. Although no significant interference was observed, several continuous wave transmissions were identified in the frequency band adjacent to the LORAN-C band. GRA

N80-29282# Transportation Systems Center, Cambridge, Mass.
VISUAL CONFIRMATION OF VOICE TAKEOFF CLEARANCE (VICON) ALTERNATIVE STUDY Final Report, May - Dec. 1979
Robert S. Yatsko May 1980 61 p refs Prepared for FAA, Washington, D.C.
(AD-A086080; TSC-FAA-80-2; FAA-RD-80-44) Avail: NTIS HC A04/MF A01 CSCL 17/7

This report presents the results of a program undertaken to study potential alternatives to the VICON (Visual Confirmation of Voice Takeoff Clearance) system which has undergone operational field tests at Bradley International Airport, Windsor Locks, Connecticut since October 1979. The tests are scheduled for completion in March 1980. This report presents alternatives from two different viewpoints namely, those alternatives that can improve certain key components of the existing VICON System, and those proposing entirely different concepts than the current concept. GRA

N80-29284# National Aviation Facilities Experimental Center, Atlantic City, N. J.
ACTIVE BEACON COLLISION AVOIDANCE SYSTEM TEST BED FOR 1978 LOS ANGELES FLIGHTS Progress Report, Jul. 1976 - Aug. 1978
Maurice Cohen and Charles Richardson May 1980 18 p ref
(AD-A086241; FAA-NA-79-12) Avail: NTIS HC A02/MF A01 CSCL 01/2

This document describes the test bed configuration of the Federal Aviation Administration (FAA)/air traffic control radar beacon system/Discrete Address Beacon System (ATCRBS/DABS) active mode beacon collision avoidance System (BCAS). BCAS is a ground-independent, air-to-air system activated by eliciting replies from surrounding altitude-reporting transponders within a 32 nautical mile radius. The BCAS provides a positive climb or dive command to the pilot 30 seconds prior to any possible collision. The BCAS also advises the pilot of all aircraft with marginally safe separation. Feasibility flight tests of the test bed configuration were conducted at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, N.J., Washington, D.C., and Los Angeles, California, from 1976 through 1978. The test bed included the multilevel power interrogation capability referred to as 'whisper-shout', intended to segregate responding aircraft transponders to distribute the computer processing workload and reduce garble. GRA

N80-29285# Federal Aviation Administration, Washington, D. C. Office of Aviation Policy.
A METHOD FOR ADMINISTRATIVE ASSIGNMENT OF RUNWAY SLOTS Final Report
Kenneth E. Geisinger Jun. 1980 53 p
(AD-A086118; FAA-AVP-80-5) Avail: NTIS HC A04/MF A01 CSCL 17/7

Federal Aviation Regulations set quotas (upper limits) on the number of operations per hour at each of four major U.S. air carrier airports: Washington National, New York LaGuardia, Chicago O'Hare International and New York Kennedy International. The reservation for one of these operations is referred to as a 'runway slot'. The runway slots designated for scheduled air carriers are periodically assigned to the various carriers in advance and airline schedules are built around them. How many slots each airline gets is determined by mutual agreement among the airlines through airline scheduling committees. These committees might be abolished and their function might have to be performed by the Federal Aviation Administration (FAA). This report presents a method for administratively assigning slots to the airlines. It is based on observations made of the scheduling committees. The major difference is that in the scheduling committees, decisions are made in order to get unanimous consent; in the administrative procedure, decisions are made to maximize a measure of passenger service. GRA

N80-29287*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.
WIND-TUNNEL EXPERIMENTS ON DIVERGENCE OF FORWARD-SWEPT WINGS
Rodney H. Ricketts and Robert V. Doggett, Jr. Aug. 1980 49 p refs
(NASA-TP-1685; L-13549) Avail: NTIS HC A03/MF A01 CSCL 01C

An experimental study to investigate the aeroelastic behavior of forward-swept wings was conducted in the Langley Transonic Dynamics Tunnel. Seven flat-plate models with varying aspect ratios and wing sweep angles were tested at low speeds in air. Three models having the same planform but different airfoil sections (i.e., flat-plate, conventional, and supercritical) were tested at transonic speeds in Freon 12. Linear analyses were performed to provide predictions to compare with the measured aeroelastic instabilities which include both static divergence and flutter. Six subcritical response testing techniques were formulated and evaluated at transonic speeds for accuracy in predicting static divergence. Two 'divergence stoppers' were developed and evaluated for use in protecting the model from structural damage during tests. Author

N80-29288# Aeronautical Research Labs., Melbourne (Australia).
WESSEX HELICOPTER/SONAR DYNAMICS STUDY ARL PROGRAM DESCRIPTION AND OPERATION
N. V. Williams, C. R. Guy, and N. E. Gilbert Feb. 1979 38 p refs
(ARL-Aero-Note-385; AR-001-603) Avail: NTIS HC A03/MF A01

A computer program, representing the dynamic behavior in flight of the Wessex MK.31B helicopter and its antisubmarine warfar (ASW) sonar equipment, is described. The program is intended for operation on a PDP 10 computer and is written in CSMP 10 (ARL) simulation language. Instructions for setting up a particular simulated flight maneuver are given, together with details of program verification. Author

N80-29289# Naval Air Systems Command, Washington, D. C.
DESIGNING ON-CONDITION TASKS FOR NAVAL AIRCRAFT
1 Mar. 1980 50 p
(AD-A085450) Avail: NTIS HC A03/MF A01 CSCL 01/3

Contents: Preventive Maintenance Processes, A History of the 'On Condition' Maintenance Process, A Comparison of Benefits; Non-Destructive Inspection and Testing -- Current Commercial Practice, Future Opportunities; Applications -- Structures, Powerplants, Examples; Designing an 'On-Condition' Task and Measuring Results -- Designing an 'On-Condition' Task, Measuring Results. GRA

N80-29290# Rockwell International Corp., Thousand Oaks, Calif. Science Center.
MECHANICAL BEHAVIOR OF AIRFRAME MATERIALS Final Report, 1 Jan. 1976 - 31 Dec. 1979
J. A. Wert, N. E. Paton, and J. C. Chesnutt Mar. 1980 46 p refs
(Contract F44620-76-C-0025; AF Proj. 2306)
(AD-A085844; SC5053.6FR; AFOSR-80-0451TR) Avail: NTIS HC A03/MF A01 CSCL 01/3

This is the final report for a program which was initiated in 1976 to systematically evaluate the influence of hydrogen on mechanical properties of alpha titanium alloys. In the second year of the program (1977), the effort was extended to include work on the properties of fine grain aluminum alloys. Both segments of the extended program have yielded promising

results which are summarized in this report. Among the more important results have been a demonstration of high sustained-load cracking rates and an acceleration of fatigue crack propagation rates by tensile hold periods in Ti-6Al containing modest amounts of hydrogen. The study of fine grain aluminum alloys has demonstrated a marked increase in exfoliation corrosion resistance in 7075 Al with fine equiaxed grain, as compared to standard commercial products. Both of these observations have important implications for the structural efficiency of Ti and Al alloys as airframe materials. GRA

N80-29291# Naval Air Development Center, Warminster, Pa. Aircraft and Crews Systems Technology Directorate.
A TIME RESPONSE APPROACH TO EQUIVALENT AIRCRAFT DYNAMICS Interim Report, Oct. 1978 - Sep. 1979
J. M. Stifel Sep. 1979 81 p refs
(WF41400000)
(AD-A085873; NADC-79231-60) Avail: NTIS HC A05/MF A01 CSCL 01/1

An analytical investigation into the basic equivalent of high-order and reduced-order aircraft dynamics is presented. The need to consider system response to inputs represented by points in the Laplace domain is explained in terms of the ability of a damped sinusoid series to the model general aperiodic pilot inputs. The region of concern in the Laplace domain is related to pilot response time by the time to the initial peak of a single damped sinusoid inputs. Several representative high-order systems and their lower order equivalents are examined for similarity of time response. A new approach for equivalent systems application is suggested based on matching time responses over the Laplace domain region. Implications of the analysis to present methods of applying equivalent systems and to suggested pilot compensation criteria are examined. The analysis leads to the conclusion that equivalent system parameters are variables dependent on Laplace domain location and that the success of current methods depend on that variation being negligible. The further conclusion is reached that if equivalent system parameters are allowed to vary, artificial time delays are unnecessary and undesirable in achieving time response similarity. GRA

N80-29292# McDonnell Aircraft Co., St. Louis, Mo.
THE EFFECTS OF GROUND WALL-JET CHARACTERISTICS ON FOUNTAIN UPWASH FLOW FORMATION AND DEVELOPMENT Final Technical Report, 15 Feb. - 15 Jun. 1980
Donald R. Kotansky and Lloyd W. Glaze 15 Jun. 1980 80 p refs
(Contract N00014-79-C-0130)
(AD-A086127; ONR-CR212-261-1F) Avail: NTIS HC A05/MF A01 CSCL 20/4

An experimental program was conducted to investigate the effects of ground wall jet characteristics on two-jet fountain upwash flow formation and development. Variations in wall jet properties were generated through parametric variations in nozzle pressure ratio and jet impingement angle. Hot film anemometer measurements of the wall jet and fountain upwash flow fields resulted in the determination of fountain upwash formation momentum recovery coefficients, fountain upwash inclination and spreading characteristics, and fountain upwash mass entrainment characteristics. The data obtained in this investigation provides empirical information required for an analytical model of fountain inclination developed during this study. This analytical model is compatible with a methodology and software for the prediction of multiple jet V/STOL aircraft ground surface flow fields previously developed for the Naval Air Development Center and later modified for the NASA Ames Research Center. GRA

N80-29293# Dreyfuss-Pellman Corp., Stamford, Conn.
NON-CONTACTING ELECTRO-OPTICAL CONTOURING OF HELICOPTER ROTOR BLADES Final Report
Marc G. Dreyfuss and Arnold Pellman Dec. 1979 47 p
(Contract DAAK50-78-C-0024)
(AD-A085820) Avail: NTIS HC A03/MF A01 CSCL 01/3

Non-contact contour measurements of helicopter rotor blades to accuracies of 0.001 inch are possible via rangefinding by triangulation employing electro-optical techniques. A prototype of a portion of such a system has been built and tested. The result of these tests indicate that the construction of the full prototype system is feasible and desirable. GRA

N80-29294# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF AEROELASTIC COUPLINGS ON AEROMECHANICAL STABILITY OF A HINGELESS ROTOR HELICOPTER
William G. Bousman 1980 14 p refs Presented at the Ann. Forum of the Am. Helicopter Soc., Washington, D.C., May 1980
(AD-A085819) Avail: NTIS HC A02/MF A01 CSCL 20/4

A 1.62 m diameter rotor model was used to investigate aeromechanical stability, and the results were compared to theory. Configurations tested included: (1) a nonmatched stiffness rotor as a baseline, (2) the baseline rotor with negative pitch-lag coupling, (3) the combination of negative pitch-lag and structural flap-lag coupling on the baseline rotor, (4) a matched stiffness rotor, and (5) a matched stiffness rotor with negative pitch-lag coupling. The measured lead-lag regressing mode damping of the five configurations agreed well with theory, but only the matched stiffness case with negative pitch-lag coupling was able to stabilize the air resonance mode. Comparison of theory and experiment for the damping of the body modes showed significant differences that may be related to rotor inflow dynamics. GRA

N80-29295*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A HEAD-UP DISPLAY FORMAT FOR APPLICATION TO TRANSPORT AIRCRAFT APPROACH AND LANDING
Richard S. Bray Jul. 1980 42 p
(NASA-TM-81199; A-8180) Avail: NTIS HC A03/MF A01 CSCL 01D

A head up display (HUD) format used in simulator studies of the application of HUD to the landing of civil transport aircraft is described in detail. The display features an indication of the aircraft's instantaneous flightpath that constitutes the primary controlled element. Discrete ILS error and altitude signals are scaled and positioned to provide precise guidance modes when tracked with the flightpath symbol. Consideration is given to both the availability and nonavailability of inertial velocity information in the aircraft. Author

N80-29297*# General Electric Co., Cincinnati, Ohio. Advanced Engineering and Technology Programs Dept.
QUIET CLEAN SHORT-HAUL EXPERIMENTAL ENGINE (QCSEE) UNDER-THE-WING (UTW) COMPOSITE NACELLE TEST REPORT. VOLUME 2: ACOUSTIC PERFORMANCE
D. L. Stimpert Nov. 1979 124 p refs 2 Vol.
(Contract NAS3-18021)
(NASA-CR-159472; R78AEG-574-Vol-2) Avail: NTIS HC A06/MF A01 CSCL 21E

High bypass geared turbofan engines with nacelles forming the propulsion system for short-haul passenger aircraft were tested for use in externally blown flap-type aircraft. System noise levels for a four-engine, UTW-powered aircraft operating in the powered lift mode were calculated to be 97.2 and 95.7 EPNdB at takeoff and approach, respectively, on a 152.4 m (500 ft) sideline compared to a goal of 95.0 EPNdB. A.R.H.

N80-29298*# General Electric Co., Cincinnati, Ohio. Advanced Engineering and Technology Programs Dept.
QUIET CLEAN SHORT-HAUL EXPERIMENTAL ENGINE (QCSEE) UNDER-THE-WING ENGINE COMPOSITE FAN BLADE: PRELIMINARY DESIGN TEST REPORT
May 1975 63 p
(Contract NAS3-18021)
(NASA-CR-134846; R75AEG411) Avail: NTIS HC A04/MF A01 CSCL 21E

Results of tests conducted on preliminary design polymeric-composite fan blade for the under the wing (UTW) OCSEE engine are presented. During this phase of the program a total of 17 preliminary OCSEE UTW composite fan blades were manufactured for various component tests including frequency characteristics, strain distribution, bench fatigue, dovetail pull, whirligig

overspeed and whirligig impact. All tests were successuflly completed with the exception of whirligig impact tests. Improvements in local impact capability are being evaluated for the OCSEE blade under other NASA and related programs. Author

N80-29299*# General Electric Co., Cincinnati, Ohio.
ACOUSTIC PERFORMANCE OF A 50.8-cm (20-INCH) DIAMETER VARIABLE-PITCH FAN AND INLET. VOLUME 2: ACOUSTIC DATA Final Report
K. R. Bilwakesh, A. Clemons, and D. L. Stimpert Nov. 1979 495 p refs 2 Vol.
(NASA-CR-135118; R77AEG229-Vol-2) Avail: NTIS HC A21/MF A01 CSCL 21E

Results from acoustic tests on a 50.8 cm (20 inch) QCSEE Under-the-Wing (UTW) engine, variable pitch fan and inlet simulator are tabulated. Tests were run in both forward and reverse thrust mdoes with a bellmouth inlet, five accelerating inlets (one hardwall and four treated), and four low Mach number inlets (one hardwall and three treated). The 1/3 octave-band acoustic data are presented for the model size on the measured 5.2 m (17.0 ft) arc and also data scaled to full QCSEE size 71:20 on a 152.4 m (500 ft) sideline. A.R.H.

N80-29300*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRCRAFT RESEARCH AND TECHNOLOGY FOR FUTURE FUELS
Jul. 1980 229 p refs Symp. held in Cleveland, Ohio, 16-17 Apr. 1980
(NASA-CP-2146; E-398) Avail: NTIS HC A11/MF A01 CSCL 21E

The potential characteristics of future aviation turbine fuels and the property effects of these fuels on propulsion system components are examined. The topics that are discussed include jet fuel supply and demand trends, the effects of refining variables on fuel properties, shekle oil processing, the characteristics of broadened property fuels, the effects of fuel property variations on combustor and fuel system performance, and combuster and fuel system technology for broadened property fuels.

N80-29301*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FUTURE AVIATION FUELS OVERVIEW
Gregory M. Reck *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 1-4 refs

Avail: NTIS HC A11/MF A01 CSCL 21D

The outlook for aviation fuels through the turn of the century is briefly discussed and the general objectives of the NASA Lewis Alternative Aviation Fuels Research Project are outlined. The NASA program involves the evaluation of potential characteristics of future jet aircraft fuels, the determination of the effects of those fuels on engine and fuel system components, and the development of a component technology to use those fuels. M.G.

N80-29302*# Department of Energy, Washington, D. C.
OUTLOOK FOR ALTERNATIVE ENERGY SOURCES
Michael E. Card *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 5-9

Avail: NTIS HC A11/MF A01 CSCL 21D

Predictions are made concerning the development of alternative energy sources in the light of the present national energy situation. Particular emphasis is given to the impact of alternative fuels development on aviation fuels. The future outlook for aircraft fuels is that for the near term, there possibly will be no major fuel changes, but minor specification changes may be possible if supplies decrease. In the midterm, a broad cut fuel may be used if current development efforts are successful. As synfuel production levels increase beyond the 1990's there may be some mixtures of petroleum-based and synfuel products with the possibility of some shale distillate and indirect coal liquefaction products near the year 2000. M.G.

N80-29303*# United Air Lines, Inc., Chicago, Ill.
CURRENT JET FUEL TRENDS
Paul P. Campbell *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 11-14

Avail: NTIS HC A11/MF A01 CSCL 21D

Data concerning the properties of commercial jet fuels during the period between 1974 and 1979 are discussed. During this period the average aromatics content of fuels increased from 16% to 17.5%. It is evident that the arrival of Alaska North Slope crude in 1977 had a significant impact upon the aromatics content of jet fuel supply at West Coast points with less effect upon the entire United States domestic market. This increase in aromatics has not been accompanied by a corresponding reduction in burning quality as measured by smoke point. There has been a reduction of .6 smoke point on the average. Looking at hydrogen content as a measure of burning quality, the all refinery average calculated hydrogen for 1978 was approximately 13.7%. The relationship between hydrogen content and aromatics content shows a slope of .043% reduction in hydrogen for 1% increase in aromatics. M.G.

N80-29304*# Boeing Commercial Airplane Co., Seattle, Wash.
AVIATION FUELS OUTLOOK
Albert M. Momenthy *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 15-24

Avail: NTIS HC A11/MF A01 CSCL 21D

Options for satisfying the future demand for commercial jet fuels are analyzed. It is concluded that the most effective means to this end are to attract more refiners to the jet fuel market and encourage development of processes to convert oil shale and coal to transportation fuels. Furthermore, changing the U.S. refineries fuel specification would not significantly alter jet fuel availability. M.G.

N80-29305*# California Univ. at Los Angeles. School of Engineering and Applied Science.
A METHODOLOGY FOR LONG-RANGE PREDICTION OF AIR TRANSPORTATION
Mohammad B. Ayati and J. Morley English *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 25-30 refs Presented at the SAE Intern. Air Transportation Meeting, Cincinnati, 20-22 May 1980

Avail: NTIS HC A11/MF A01 CSCL 01C

A framework and methodology for long term projection of demand for aviation fuels is presented. The approach taken includes two basic components. The first was a new technique for establishing the socio-economic environment within which the future aviation industry is embedded. The concept utilized was a definition of an overall societal objective for the very long run future. Within a framework so defined, a set of scenarios by which the future will unfold are then written. These scenarios provide the determinants of the air transport industry operations and accordingly provide an assessment of future fuel requirements. The second part was the modeling of the industry in terms of an abstracted set of variables to represent the overall industry performance on a macro scale. The model was validated by testing the desired output variables from the model with historical data over the past decades. M.G.

N80-29306*# Exxon Research and Engineering Co., Linden, N.J.
EFFECT OF REFINING VARIABLES ON THE PROPERTIES AND COMPOSITION OF JP-5
Martin Lieberman and William F. Taylor *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 31-39
(Contract N00140-78-C-1491)
Avail: NTIS HC A11/MF A01 CSCL 21D

Potential future problem areas that could arise from changes in the composition, properties, and potential availability of JP-5 produced in the near future are identified. Potential fuel problems concerning thermal stability, lubricity, low temperature flow, combustion, and the effect of the use of specific additives on

fuel properties and performance are discussed. An assessment of available crudes and refinery capabilities is given. M.G.

N80-29307*# Douglas Aircraft Co., Inc., Santa Monica, Calif.
FUEL/ENGINE/AIRFRAME TRADEOFF STUDY, PHASE 1
A. T. Peacock *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 41-47 Sponsored by AF
Avail: NTIS HC A11/MF A01 CSCL 21E

The effects of broadening the specifications for JP-4 and JP-8 fueld on the performance and cost of all USAF aircraft presently using JP-4 as well as those expected to be introduced into the force structure by 1983 are investigated. Test results indicated that there was no impact on engine performance, turbine durability, and coking, however there was a small maintenance cost increase as a result of a small combustor life decrease. Using JP-4 as standard fuel will avoid the use of high demand middle distillate fuels and give producers flexibility. Extensive use of JP-8 in the United States will increase middle distillate demand and cause a slight increase in engine hot-section maintenance. It is also concluded that the maximum allowable freeze point of JP-4 or JP-8 cannot be increased without degrading system performance and safety as critical conditions are approached. M.G.

N80-29308*# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
MILITARY JET FUEL FROM SHALE OIL
Edward N. Coppola *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 49-57 refs

Avail: NTIS HC A11/MF A01 CSCL 21D

Investigations leading to a specification for aviation turbine fuel produced from whole crude shale oil are described. Refining methods involving hydrocracking, hydrotreating, and extraction processes are briefly examined and their production capabilities are assessed. M.G.

N80-29309*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FUELS CHARACTERIZATION STUDIES
Gary T. Seng, Albert C. Antoine, and Francisco J. Flores *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 59-65 refs
Avail: NTIS HC A11/MF A01 CSCL 21D

Current analytical techniques used in the characterization of broadened properties fuels are briefly described. Included are liquid chromatography, gas chromatography, and nuclear magnetic resonance spectroscopy. High performance liquid chromatographic ground-type methods development is being approached from several directions, including aromatic fraction standards development and the elimination of standards through removal or partial removal of the alkene and aromatic fractions or through the use of whole fuel refractive index values. More sensitive methods for alkene determinations using an ultraviolet-visible detector are also being pursued. Some of the more successful gas chromatographic physical property determinations for petroleum derived fuels are the distillation curve (simulated distillation), heat of combustion, hydrogen content, API gravity, viscosity, flash point, and (to a lesser extent) freezing point. M.G.

N80-29310*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBUSTION TECHNOLOGY OVERVIEW
Richard W. Niedzwiecki *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 67-73 refs

Avail: NTIS HC A11/MF A01 CSCL 21B

An overview of combustor technology developments required for use of broadened property fuels in jet aircraft is presented. The intent of current investigations is to determine the extent to which fuel properties can be varied, to obtain a data base of combustion - fuel quality effects, and to determine the trade-offs associated with broadened property fuels. Subcomponents of in-service combustors such as fuel injectors and liners, as well as air distributions and stoichiometry, are being altered to determine the extent to which fuel flexibility can be extended. Finally, very advanced technology consisting of new combustor concepts is being evolved to optimize the fuel flexibility of gas turbine combustors. M.G.

N80-29311*# General Electric Co., Fairfield, Conn.
EXPERIMENTAL COMBUSTOR STUDY PROGRAM
John M. Kasper and Edward E. Ekstedt *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 75-82
Avail: NTIS HC A11/MF A01 CSCL 21E

Advanced combustor concepts are evaluated as a means of accommodating possible future broad specification fuels. The three advanced double annular combustor concepts consisted of (1) a concept employing high pressure drop fuel nozzles for improved atomization, (2) a concept with premixing tubes in the main stage, and (3) a concept with the pilot stage on the inside and the main stage on the sideout, which is the reverse of the other two concepts. All of the advanced concepts show promise for reduced sensitivity to fuel hydrogen content. Some hardware problems were encountered, but these problems could be quickly resolved if refinement tests were conducted. The design with the premixing main stage was selected for a parametric test because of its low NOx emissions level, carbon free dome, and very low dome temperatures which were essentially independent of fuel type. The other advanced designs also had low done temperatures. The premixing dome design liner temperatures exhibited less sensitivity to fuel type than did the base-line combustor, although more sensitivity than observed for concept 1. The inner liner hot spot and the observed smoke results for the premixing design suggest that the fuel-air mixture was not as uniform as desired. M.G.

N80-29312*# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
FUEL CHARACTER EFFECTS ON THE J79 AND F101 *ENGINE COMBUSTION SYSTEMS*
Thomas A. Jackson *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 83-93

Avail: NTIS HC A11/MF A01 CSCL 21E

The effects of select fuel property variations on two major engine classifications are summarized. Thirteen refined and blended fuels were used which exhibited significant variations in hydrogen content, aromatic type, initial boiling point, final boiling point, and viscosity. Trends were very similar but the degree of fuel sensitivity was not constant. For both systems the dominant fuel property during high pressure operation was found to be fuel hydrogen content. For operation at low pressure test points the fuel volatility and viscosity became the dominant fuel properties for both systems. Aromatic type and final boiling point did not significantly affect combustion data. Correlations of other fuel properties with these and other performance parameters are presented. E.D.K.

N80-29313*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NASA BROADENED-SPECIFICATION FUELS COMBUSTION TECHNOLOGY PROGRAM
James S. Fear *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 95-98

Avail: NTIS HC A11/MF A01 CSCL 21B

The broadened-Specification Fuels Combustion Technology program's purpose is to evolve and demonstrate the technology required to enable current and next generation high-thrust, high-bypass-ratio turbofan engines to use fuels with broadened properties and to verify the evolved technology in full scale engine tests. The three phases of the program are combustor concept screening, combustor optimization testing, and engine verification testing. Constraints for designing combustion systems are outlined and problems to be expected in the use of broadened properties fuels are listed. E.D.K.

N80-29314*# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

AIR FORCE FUEL MAINBURNER/TURBINE EFFECTS PROGRAMS
Thomas A. Jackson *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 99-103

Avail: NTIS HC A11/MF A01 CSCL 21E

A program for the determination of fuel property effects on aircraft gas turbine engine mainburners and turbines is discussed. The six engines selected as test candiates are the J79, J85, J57, TF30, TF39, and F100. Fuels election is the responsibility of the contractors with two fuels as exceptions. The petroleum JP-4 is to be used as a baseline in all tests. The shale JP-4 is to be used in nearly all tests. Fuel properties are to be correlated with combustion system performance paramters. In addition, life predictions are to be made for combustor and turbine hardware. These predictions are to be based on a typical mission for each system, measured metal temperatures and temperature gradients, and oxidation/corrosion effects. E.D.K.

N80-29315*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.
THE BROADENED-SPECIFICATION FUELS COMBUSTION TECHNOLOGY PROGRAM AT PRATT AND WHITNEY AIRCRAFT
Robert P. Lohmann *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 105-108

Avail: NTIS HC A11/MF A01 CSCL 21B

The impact of the use of broadened specification fuels on combustor design was investigated. Particular emphasis was placed on establishing the viability of various combustor modifications to permit the use of broadened specification fuels while meeting exhaust emissions and performance specifications and maintaining acceptable combustor operational and durability characteristics. Three different combustor concepts will be evaluated. Various design modifications on the operating capability of each of the combustor concepts with experimental referee broadened specification Fuel. The modifications that were evaluated included perturbations of the combustor airflow schedules to alter local stoichiometry and residence time histories revisions to the fuel injectors, and variations in liner cooling including the use of thermal barrier coatings and/or advanced cooling concepts. R.C.T.

N80-29316*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
NASA/GENERAL ELECTRIC BROAD-SPECIFICATION FUELS COMBUSTION TECHNOLOGY PROGRAM, PHASE 1
Willard J. Dodds *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 109-113

Avail: NTIS HC A11/MF A01 CSCL 21D

The use of broad specification fuels in aircraft turbine engine combustion systems was examined. Three different combustor design concepts were evaluated for their ability to use broad specification fuels while meeting several specific emissions, performance, and durability goals. These combustor concepts covered a range from those having limited complexity and relatively low technical risk to those having high potential for achieving all of the program goals at the expense of increased technical risk. R.C.T.

N80-29317*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FUELS RESEARCH: COMBUSTION EFFECTS OVERVIEW
John B. Haggard, Jr. *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 115-116

Avail: NTIS HC A11/MF A01 CSCL 21B

The effects of broadened property fuels on gas turbine combustors were assessed. Those physical and chemical properties of fuels that affect aviation gas turbine combustion were isolated and identified. Combustion sensitivity to variations in particular fuel properties were determined. Advanced combustion concepts and subcomponents that could lessen the effect of using broadened property fuels were also identified. R.C.T.

N80-29318*# Purdue Univ., Lafayette, Ind.
ATOMIZATION OF BROAD SPECIFICATION AIRCRAFT FUELS
J. G. Skifstad and A. H. Lefebvre *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 117-124

Avail: NTIS HC A11/MF A01 CSCL 21D

The atomization properties of liquid fuels for the potential use in aircraft gas turbine engines are discussed. The significance of these properties are addressed with respect to the ignition and subsequent combustion behavior of the fuel spray/air mixture. It is shown that the fuel properties which affect the atomization behavior (viscosity, surface tension, and density) are less favorable for the broad specification fuels as compared to with those for conventional fuels. R.C.T.

N80-29319*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANTIMISTING KEROSENE
Harold W. Schmidt *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 125-130

Avail: NTIS HC A11/MF A01 CSCL 21D

The antimisting additive ((FM-9) was tested in terms of its propulsion systems performance. The effect of the additive on engine operation was evaluated, operating problems were identified, the adaptability of engines to antimisting kerosene was assessed, and the potential viability of this fuel for use in present and future fan jet engines was determined. R.C.T.

N80-29320*# Massachusetts Inst. of Tech., Cambridge.
SOOT FORMATION AND BURNOUT IN FLAMES
B. Prado, J. D. Bittner, K. Neoh, and J. B. Howard *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 131-137 refs

Avail: NTIS HC A11/MF A01 CSCL 21B

The amount of soot formed when burning a benzene/hexane mixture in a turbulent combustor was examined. Soot concentration profiles in the same combustor for kerosene fuel are given. The chemistry of the formation of soot precursors, the nucleation, growth and subsequent burnout of soot particles, and the effect of mixing on the previous steps were considered. R.C.T.

N80-29321*# Exxon Research and Engineering Co., Linden, N.J.
FUEL PROPERTY EFFECTS IN STIRRED COMBUSTORS
In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 139-146 Sponsored by DOE

Avail: NTIS HC A11/MF A01 CSCL 21E

Soot formation in strongly backmixed combustion was investigated using the jet-stirred combustor (JSC). This device provided a combustion volume in which temperature and combustion were uniform. It simulated the recirculating characteristics of the gas turbine primary zone; it was in this zone where mixture conditions were sufficiently rich to produce soot. Results indicate that the JSC allows study of soot formation in an aerodynamic situation revelant to gas turbines. R.C.T.

N80-29322*# Southwest Research Inst., San Antonio, Tex.
EFFECT OF FUEL MOLECULAR STRUCTURE ON SOOT FORMATION IN GAS TURBINE COMBUSTION
D. W. Naegeli and C. A. Moses *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 147-152

Avail: NTIS HC A11/MF A01 CSCL 21B

The effect of fuel variations at the same hydrogen content on the formation of soot in a gas turbine combustor was studied. Six fuels were burned to a combustor over a matrix of about 50 test conditions with test conditions ranging over 500-1800 kPa (5-18 atm) pressure and 500-1000 K burner inlet temperature; fuel-air ratios were varied from 0.008-0.024. Flame

radiation measurements were made through a sapphire window toward the end of the primary zone. The hydrogen content of the six test fuels ranged from 12.80 to 12.88%. Five fuels emphasized hydrocarbon types: (mono, di, and tricyclic), naphthenes (decalin) and partially hydrogenated aromatics (tetralin); the sixth fuel emphasized final boiling point. R.C.T.

N80-29323*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY STUDIES OF COMBUSTOR SENSITIVITY TO ALTERNATIVE FUELS
Francis M. Humenik *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 153-160 refs

Avail: NTIS HC A11/MF A01 CSCL 21B

Combustion problems associated with using alternative fuels ground power and aeropropulsion applications were studied. Rectangular sections designed to simulate large annular combustor test conditions were examined. The effects of using alternative fuels with reduced hydrogen content, increased aromatic content, and a broad variation in fuel property characteristics were also studied. Data of special interest were collected which include: flame radiation characteristics in the various combustor zones; the correponding increase in liner temperature from increased radiant heat flux; the effect of fuel bound nitrogen on oxides of nitrogen (NO sub x) emissions; and the overall total effect of fuel variations on exhaust emissions. R.C.T.

N80-29324*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FUELS RESEARCH: FUEL THERMAL STABILITY OVERVIEW
Stephen M. Cohen *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 161-168 ref

Avail: NTIS HC A11/MF A01 CSCL 21B

Alternative fuels or crude supplies are examined with respect to satisfying aviation fuel needs for the next 50 years. The thermal stability of potential future fuels is discussed and the effects of these characteristics on aircraft fuel systems are examined. Advanced fuel system technology and design guidelines for future fuels with lower thermal stability are reported. R.C.T.

N80-29325*# United Technologies Research Center, East Hartford, Conn.
EXPERIMENTAL STUDY OF TURBINE FUEL THERMAL STABILITY IN AN AIRCRAFT FUEL SYSTEM SIMULATOR
Alexander Vranos and Pierre J. Marteney *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 169-179 ref

(Contract NAS3-21593)
Avail: NTIS HC A11/MF A01 CSCL 21D

The thermal stability of aircraft gas turbines fuels was investigated. The objectives were: (1) to design and build an aircraft fuel system simulator; (2) to establish criteria for quantitative assessment of fuel thermal degradation; and (3) to measure the thermal degradation of Jet A and an alternative fuel. Accordingly, an aircraft fuel system simulator was built and the coking tendencies of Jet A and a model alternative fuel (No. 2 heating oil) were measured over a range of temperatures, pressures, flows, and fuel inlet conditions. R.C.T.

N80-29326*# Naval Air Propulsion Test Center, Trenton, N.J.
DETERMINATION OF JET FUEL THERMAL DEPOSIT RATE USING A MODIFIED JFTOT
C. J. Nowack and R. J. Delfosse *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 181-184

Avail: NTIS HC A11/MF A01 CSCL 21D

Three fuels having different breakpoint temperatures were studied in the modified jet fuel thermal oxidation tester. The lower stability fuel with a breakpoint of 240 C was first stressed at a constant temperature. After repeating this procedure at several different temperatures, an Arrehenius plot was drawn from the data. The correlation coefficient and the energy of activation were calculated to be 0.97 and 8 kcal/mole respectively. Two other fuels having breakpoint temperatures of 271 C and 285 C were also studied in a similar manner. A straight line was drawn through the data at a slope equivalent to the slope of the lower stability fuel. The deposit formation rates for the three fuels were determined at 260 C, and a relative deposit formation rate at this temperature was calculated and plotted as a function of the individual fuel's breakpoint temperatures. R.C.T.

N80-29327*# Colorado School of Mines, Golden.
MECHANISMS OF NITROGEN HETEROCYCLE INFLUENCE ON TURBINE FUEL STABILITY
Stephen R. Daniel and Jonathan H. Worstell *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 185-193
(Contract NsG-3122)
Avail: NTIS HC A11/MF A01 CSCL 21D

Lewis bases were extracted from a Utah COED syncrude via ligand exchange. Addition of this extract to Jet A at levels as low as 5 ppm N produced deterioration of stability in both JFTOT and accelerated storage tests (7 days at 394 K with 13:1 air to fuel ratio). Comparable effects on Jet A stability were obtained by addition of pyridine and quinoline, while pyrrole and indole were less detrimental at the same concentration level. The weight of deposit produced accelerated storage tests was found to be proportional to the concentration of added nitrogen compound. Over the narrow temperature range accessible with the experimental method, Arrhenius plots obtained by assuming specific rate to be proportional to the weight of material deposited in seven days exhibit greater slopes in the presence of those nitrogen compounds producing the greater deposition rates. It is shown that despite variation in appearance the elemental composition and spectral characteristics of the deposits are unaffected by addition of the nitrogen compounds. The linearity of the Arrhenius plots and of a plot of Arrhenius slope versus intercept for all the compounds suggests a constancy of mechanism over the range of temperature and heterocycles studied. R.C.T.

N80-29328*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FUEL SYSTEM TECHNOLOGY OVERVIEW
Robert Friedman *In its* Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 195-203 refs

Avail: NTIS HC A11/MF A01 CSCL 21E

Fuel system research and technology studies are being conducted to investigate the correlations and interactions of aircraft fuel system design and environment with applicable characteristics of the fuel. Topics include: (1) analysis of in-flight fuel temperatures; (2) fuel systems for high freezing point fuels; (3) experimental study of low temperature pumpability; (4) full scale fuel tank simulation; and (5) rapid freezing point measurement. E.D.K.

N80-29329*# Boeing Military Airplane Development, Seattle, Wash.
HIGH-FREEZING-POINT FUEL STUDIES
Frederick F. Tolle *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 205-219 refs

Avail: NTIS HC A11/MF A01 CSCL 21D

Considerable progress in developing the experimental and analytical techniques needed to design airplanes to accomodate fuels with less stringent low temperature specifications is reported. A computer technique for calculating fuel temperature profiles in full tanks was developed. The computer program is being extended to include the case of partially empty tanks. Ultimately, the completed package is to be incorporated into an aircraft fuel tank thermal analyser code to permit the designer to fly various thermal exposure patterns, study fuel temperatures versus time, and determine holdup. E.D.K.

N80-29330*# Lockheed-California Co., Burbank.
LOW TEMPERATURE FUEL BEHAVIOR STUDIES

Francis J. Stockemer *In* NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 221-233 refs

(Contract NAS3-20814)
Avail: NTIS HC A11/MF A01 CSCL 21E

Aircraft fuels at low temperatures near the freezing point. The principal objective was an improved understanding of the flowability and pumpability of the fuels in a facility that simulated the heat transfer and temperature profiles encountered during flight in the long range commercial wing tanks. R.C.T.

N80-29332*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INVESTIGATION OF PERFORMANCE DETERIORATION OF THE CF6/JT9D, HIGH-BYPASS RATIO TURBOFAN ENGINES
Joseph A. Ziemianski and Charles M. Mehalic 1980 22 p refs Proposed for presentation at the 56th AGARD Propulsion and Energetics Symp. on Turbine Engine Testing, Turin, 29 Sep. - 3 Oct. 1980 and SAE Aerospace Congr., Los Angeles, 13-16 Oct. 1980
(NASA-TM-81552; E-511) Avail: NTIS HC A02/MF A01 CSCL 21E

The aircraft energy efficiency program within NASA is developing technology required to improve the fuel efficiency of commercial subsonic transport aricraft. One segment of this program includes engine diagnostics which is directed toward determining the sources and causes of performance deterioration in the Pratt and Whitney Aircraft JT9D and General Electric CF6 high-bypass ratio turbofan engines and developing technology for minimizing the performance losses. Results of engine performance deterioration investigations based on historical data, special engine tests, and specific tests to define the influence of flight loads and component clearances on performance are presented. The results of analysis of several damage mechanisms that contribute to performance deterioration such as blade tip rubs, airfoil surface roughness and erosion, and thermal distortion are also included. The significance of these damage mechanisms on component and overall engine performance is discussed. A.R.H.

N80-29333*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESCRIPTION OF THE WARM CORE TURBINE FACILITY RECENTLY INSTALLED AT NASA LEWIS RESEARCH CENTER
W. J. Whitney, R. G. Stabe, and T. P. Moffitt 1980 18 p refs Proposed for presentation at Aerospace Congr., Los Angeles, 13-16 Oct. 1980; sponsored by Am. Soc. of Automotive Engrs.
(NASA-TM-81562; E-524) Avail: NTIS HC A02/MF A01 CSCL 21E

The two net facilities were installed and operated at their design, or rated conditions. The important feature of both of these facilities is that the ratio of turbine inlet temperature to coolant temperature encountered in high temperature engines can be duplicated at moderate turbine inlet temperature. The limits of the facilities with regard to maximum temperature, maximum pressure, maximum mass flow rate, turbine size, and dynamometer torque-speed characteristics are discussed. Author

N80-29334# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
NOISE SUPPRESSION IN JET INLETS Final Technical Report, 1 Feb. 1979 - 31 Jan. 1980
Ben T. Zinn, William L. Meyer, and Brady R. Daniel Feb. 1980 57 p refs
(Contract F49620-77-C-0066; AF Proj. 2307)
(AD-A085403; AFOSR-80-0452TR) Avail: NTIS HC A04/MF A01 CSCL 21/5

This research program was concerned with the development of an analytical technique, based on an integral representation of the external solutions of the Helmholtz equation, for the prediction of the sound radiated from complicated, acoustically lined, axisymmetric bodies having complex sound sources. The purpose of this research program was to generate efficient computer codes for the prediction of the sound radiated from acoustically lined jet engine inlets. In the experimental tests two geometrical configurations were studied, a straight duct and a jet engine inlet. Both of these configurations were tested with hard walls and the straight duct was tested with an acoustic liner consisting of a matrix of Helmholtz resonators. It was found that very good agreement was obtained for the hard walled configurations while there were some discrepancies with the lined wall case. It is conjectured that this discrepancy in some of the lined wall results is mainly due to the particular liner theory used to calculate the effective admittance of the liner. GRA

N80-29335# Solar Turbines International, San Diego, Calif.
COMPLEX, PRECISION CAST COLUMBIUM ALLOY GAS TURBINE ENGINE NOZZLES COATED TO RESIST OXIDATION Final Report, 2 Aug. 1976 - 2 Aug. 1979
Lulu Hsu and W. G. Stevens Apr. 1980 144 p refs
(Contract DAAG46-76-C-0053)
(AD-A086128; SR80-R-4444-25; USAAVRADCOM-TR-80-F-2)
Avail: NTIS HC A07/MF A01 CSCL 11/6

The objectives of this program were to produce investment cast single vane nozzle segments in C129Y alloy (NB-10HF-10W-0.3Y) and to coat these vanes with the NS-4 (50W-20Mo-15Ti-10V) silicide coating. Initially, both cored and solid vane segments were specified but due to problems experienced in the consumable arc process, cored vanes were deleted from the program scope. Several problems developed. The electrode material supplied was low in yttrium, which might have contributed to the poor fluidity during arc melt and incomplete fill of thin walled sections. The solid nozzles and round test bars were acceptable and were used in coating processing and testing. Process specifications for both slurry spray and dip applications of the NS-4 modifier were prepared. Tensile and stress rupture tests of coated specimens displayed exceptional properties at elevated temperatures and showed superiority to cobalt-base vane alloys. Isothermal oxidation lives in excess of 5500 hours (at 760 and 1093 C) were exhibited by NS-4 coated C129Y specimens. In rig testing, under the severe thermal cycles and profiles imposed, the airfoil specimens typically survived about 100 Hours. GRA

N80-29336# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
F101 CENTRAL INTEGRATED TEST SUBSYSTEM EVALUATION Final Technical Report, 2 Apr. - 31 Dec. 1979
C. T. Vincent and C. A. Arulf Feb. 1980 137 p
(Contract F33615-79-C-2022; AF Proj. 3066)
(AD-A086130; R79AEG622; AFWAL-TR-80-2002) Avail: NTIS HC A07/MF A01 CSCL 21/5

Existing B-1/F101 flight data were used to determine the technical application and results of the diagnostic and monitoring systems utilized in the CITS. Contractor's analyses performed in support of the B-1 program provide the starting point for this program. The CTIS functions investigated were (1) fault detection and isolation, (2) flight readiness status, (3) LCF and time at temperature counting, and (4) trend data acquisition. The data evaluation had four objectives: (1) Determine how well the B-1/F101 diagnostic and monitoring requirements/goals were met; (2) establish the rates of false indication; (3) categorize the maintenance actions taken on the basis of CITS inputs; and (4) determine the effectiveness of the trending program. In addition, the effectiveness of the F101 CITS parameter and data sampling rates was determined. Continuous recorded CITS data were used to evaluate usage tracking parameters and their effectiveness in determining maintenance actions. GRA

N80-29338# ARO, Inc., Arnold Air Force Station, Tenn.
FLOW QUALITY FOR TURBINE ENGINE LOADS SIMULATOR (TELS) FACILITY Final Report, 1 Oct. 1978 - 1 Sep. 1979
R. J. Schulz Jun. 1980 38 p refs
(AD-A086084; AEDC-TR-79-83) Avail: NTIS HC A03/MF A01 CSCL 21/5

A study was made to define the flow quality in air inlets used to support engine testing in the proposed Turbine Engine Loads Simulator Facility (TELS). The study showed that inlets

could be designed that would produce separation-free flow for the worst case of crossflow induced by TELS rotation. The severity of recirculated exhaust gas ingestion by the inlet was estimated using a finite-difference numerical simulation of the engine and its exhaust deflector. Finally, a method was devised for defining the performance of a representative engine, the Pratt and Whitney F100 engine. The possible effects of inlet flow nonuniformity on engine performance in TELS were detailed. GRA

N80-29339# Air Force Materials Lab., Wright-Patterson AFB, Ohio. Metals and Ceramics Div.

SOFT BODY IMPACT OF CANTILEVER BEAMS Interim Technical Report, Oct. 1977 - Jul. 1979

Jeffry D. Sharp Mar. 1980 76 p refs

(AF Proj. 2418)

(AD-A086049; AFML-TR-79-4169) Avail: NTIS HC A05/MF A01 CSCL 21/5

Damage incurred by gas turbine engine fan blades due to foreign object ingestion is of great concern to both manufacturers and the agencies that purchase such products. Of particular interest is the response of a structure impacted by a soft body, such as a bird. As a result, efforts have been made in the last several years to understand the dynamic behavior of blade-like structures under impact loading. A great deal of information is available concerning the hard body impact problem. However, the soft body impact problem has not yet been investigated as thoroughly. This study experimentally and analytically investigates the stress/time response of a cantilever beam subjected to impact loading from a soft object. Results from several different analytical models employing the Euler-Bernoulli Beam Theory are compared to experimental data, and the validity of each model is assessed. The effects of structural damping, beam dimensions and the Timoshenko Theory parameters are discussed and conclusions as to their importance are drawn. It was determined that a cantilever beam impacted by a soft body can be accurately modeled as a forced vibration problem using the Euler-Bernoulli Theory and linear modal analysis with damping. In addition, it was shown that large structures can be linearly scaled down for impact testing without affecting the results. GRA

N80-29340# ARO, Inc., Arnold Air Force Station, Tenn.

DEVELOPMENT OF A NONINTERFERENCE TECHNIQUE FOR MEASUREMENT OF TURBINE ENGINE COMPRESSOR BLADE STRESS Final Report, 1 Jul. 1976 - 30 Dec. 1978

P. E. McCarty and J. W. Thompson, Jr. AEDC Jun. 1980 47 p refs

(AD-A086170; AEDC-TR-79-78) Avail: NTIS HC A03/MF A01 CSCL 21/5

A noninterference technique for measuring stress in compressor blades of turbine engines is being developed to alleviate disadvantages associated with conventional strain-gage measurement systems. This technique utilizes blade tip deflection measurements and special data processing algorithms to infer local blade stress. A prototype noninterference processing system for inferring blade stress from a single compressor stage, from blade vibrations nonintegral to engine speed has been developed. Blade stress amplitude and spectral information are displayed on conventional strain-gage-type displays with which the blade stress analyst is intimately familiar. The prototype system has been checked by comparison with existing recorded strain-gage test data sampled to simulate blade tip deflection measurements. GRA

N80-29341*# National Materials Advisory Board, Washington, D. C.

RELIABILITY OF CERAMICS FOR HEAT ENGINE APPLICATIONS Final Report

1980 151 p refs Sponsored in part by NASA

(Contract MDA903-78-C-0038)

(NASA-CR-163435; PB80-182678; NMAB-357) Avail: NTIS HC A08/MF A01 CSCL 21E

The advantages and disadvantages associated with the use of monolithic ceramics in heat engines are discussed. The principle gaps in the state of understanding of ceramic material, failure origins, nondestructive tests as well as life prediction are included. R.C.T.

N80-29342# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

CERAMICS FOR TURBINE ENGINE APPLICATIONS

Mar. 1980 353 p refs In ENGLISH; partly in FRENCH Presented at the 49th Meeting of the AGARD Struct. and Mater. Panel, Cologne, 8-10 Oct. 1979

(AGARD-CP-276; ISBN-92-835-0261-2) Avail: NTIS HC A16/MF A01

Advances in high temperature materials technology and/or the design and fabrication approaches to use them to increase the performance or durability, or to reduce the cost of turbine engines are assessed. One specific approach investigated involves high temperature ceramics and the associated design technology for using brittle materials in automobile engines and electric power generators. The design, fabrication, and testing of actual components are reported and the results are evaluated for aerospace applications.

N80-29343# General Electric Co., Lynn, Mass. Aircraft Engine Group.

BENEFITS OF CERAMICS TO GAS TURBINES

Arnold Brooks and Albert I. Bellin *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 25 p refs

Avail: NTIS HC A16/MF A01

The potential areas of benefit of structural ceramics in advanced propulsion engines for manned and short-life, unmanned aircraft applications are addressed. Ceramic characteristics such as rupture strength, creep, oxidation and corrosion are viewed in the perspective of advanced metal alloys. For various engine elements, operating regimes are indicated in which ceramics are anticipated to have benefits over metal parts. Considerations of cooling requirements, contours and tolerances, clearances and contacts, inspection and proof tests are discussed and their impact on engine performance, durability, and cost are assessed. For parts such as turbine blades and vances, bearings, combustors and flame-holders, establishment of benefit for ceramics is dependent upon the engine size. An example is presented for a ceramic turbine blade which shows that for conventional scaling, the probability of part survival decreases as engine size increases due to the brittle, statistical, volume dependent characteristics of the material. In general, as engine size increases, the design approaches and the degree of benefit for various ceramic parts will be modified and/or a size limit will be reached. Within the ceramic payoff regime, low cost relative to metal parts is anticipated to be a significant benefit. J.M.S.

N80-29344# Army Materials and Mechanics Research Center, Watertown, Mass.

CERAMICS FOR SMALL AIRBORNE ENGINE APPLICATIONS

R. Nathan Katz and Edward M. Lenoe *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 13 p refs

Avail: NTIS HC A16/MF A01

The likelihood for successful application of ceramics to several classes of airborne engines with different duty cycles is assessed. The general design criteria and associated key materials and requirements for generic engines for limited, APU, and man-rate helicopter use are addressed. Materials, processes, design approaches, and reliability considerations appropriate to each generic engine category are briefly discussed. A scenario for a least risk strategy for the introduction of ceramics into airborne engines will presented. Key issues in materials research and development are identified. J.M.S.

N80-29345# Noel Penny Turbines Ltd., Toll Bar End (England). Engineering Analysis Dept.

REQUIREMENTS FOR MATERIALS FOR LAND VEHICLE GAS TURBINES

D. F. Moss *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 11 p refs

Avail: NTIS HC A16/MF A01

The requirements for land-vehicle power plants are discussed. It is shown how engine concepts and working cycles are being

developed, and how improvements in materials will contribute to making the gas turbine a major competitor in this field.
J.M.S.

N80-29346# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
TECHNOLOGIES FOR USE OF CERAMICS IN TURBOENGINES
Serge Boundigues and Georges Fratacci (Direction des Recherches, Etude et Techniques, Paris) *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 13 p In FRENCH; ENGLISH summary

Avail: NTIS HC A16/MF A01
The problems raised by the introduction of ceramics in aircraft engines are discussed from two view points, adaptation of technological solutions used for metals, and concept of aerodynamics and turbine technology adapted to ceramic materials. After an aerothermodynamic justification of the contrarotative solutions proposed, several formulas of turbines integrated in a complete engine are presented. The aerodynamic loads, temperature, stresses, batch fabrication, and fixation on the disc circumference are determined for the blades. The stress level, the possibility of fretting with fibers, and the thermal insulation are determined for the discs. Ideas on the adaptation of the classical formulas to ceramics are presented along with, in particular, a technique reducing pressure losses upstream and downstream of a ceramics heat exchanger. J.M.S.

N80-29347# AiResearch Mfg. Co., Phoenix, Ariz.
SILICON NITRIDE TURBINE BLADE DEVELOPMENT
F. Blake Wallace, John E. Harper, Carl R. Dins, David W. Richerson, and Harry L. Kington *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 12 p

Avail: NTIS HC A16/MF A01
Hot-pressed silicon nitride (HPSN) rotor blades were developed as part of a two stage turbine. Program activities are described including design optimization to minimize steady-state and vibratory stress, material characterization, attachment tests, manufacturing process development, inspection, proof tests, turbine-rig development, and engine tests. This program demonstrates for the first time that ceramics can withstand the severe environment imposed on gas turbine rotating components, and that the potential for engines with increased efficiency and decreased use of strategic materials can be realized. J.M.S.

N80-29348# Ford Motor Co., Dearborn, Mich. Engineer and Research Staff.
DUO-DENSITY CERAMIC TURBINE ROTOR: CONCEPTS, MATERIALS PROCESSES AND TEST RESULTS
R. R. Baker and A. F. McLean *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 19 p refs Sponsored in part by DARPA, DOE and Army Materials and Mechanics Research Center

Avail: NTIS HC A16/MF A01
The duo-density ceramic turbine rotor concept utilizes the high strength of hot pressed silicon nitride in the simple-shaped hub and adequately high strength of reaction bonded silicon nitride for the complex-shaped blades which can be readily formed by injection molding or slip casting. Design concepts, materials and fabrication process for making duo-density rotors are presented including recent developments in Ford's hot press/press bonding process. Background and status of the Ford/DARPA rotor testing program is presented including cold spin test and hot spin test results on duo-density rotors. Recommendations are presented for follow-on work. Author

N80-29349# Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.
DEVELOPMENT OF AN INTEGRAL CERAMIC BLADE-METAL DISK WITH CIRCUMFERENTIAL BLADE ATTACHMENT
S. A. McLeod, B. H. Walker, and M. I. Mendelson *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 10 p refs Sponsored by DARPA

Avail: NTIS HC A16/MF A01
The development of a hydrid turbine rotor by attaching hot-pressed Si3N4 airfoils to a wrought AF2-1DA superalloy disk using the GATORIZING forging process is summarized. An approach for fabricating low cost ceramic airfoils (platformless blades) is discussed. The ceramic blade rotors were hot spin tested at 750 rev/s (45,000 rpm) and 1505 K blade temperature, which were representative of small gas turbine engine conditions. J.M.S.

N80-29350# Daimler-Benz A. G., Stuttgart (West Germany).
INVESTIGATIONS OF A HOT-PRESSED SILICON NITRIDE TURBINE ROTOR
Eberhard Tiefenbacher *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 9 p

Avail: NTIS HC A16/MF A01
The development of turbine wheels consisting of hot-pressed silicon nitride is reported. The preliminary tests carried out to examine the thermal shock characteristics of hot-pressed silicon nitride are described. An explantation of the aerodynamic design and calculation of the turbine wheel is included. Reference is also made to turbine wheel manufacturing and the results of tests carried out so far. J.M.S.

N80-29351# Naval Air Systems Command, Washington, D. C. Materials and Processes Branch
CERAMICS IN ROLLING ELEMENT BEARINGS
Charles F. Bersch *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 6 p refs

Avail: NTIS HC A16/MF A01
The feasibilty of using hot pressed silicon nitride (HPSN) for rolling elements and for races in ball bearings and roller bearings is explored. The HPSN offers opportunities to allenviate many current bearing problems including DN and fatigue life limitations, lubricant and cooling system deficiencies, and extreme environment demands. The history of ceramic bearings and the results of various element tests, bearing tests in rigs and bearing tests in a turbine engine are reviewed. The advantages and problems associated with the use of HPSN in rolling element bearings are discussed. Author

N80-29352# United Kingdom Atomic Energy Authority, Springfields (England). Springfields Nuclear Power Development Labs.
THE FABRICATION AND PROPERTIES OF REFEL SILICON CARBIDE IN RELATION TO GAS TURBINE COMPONENTS
P. Kennedy *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 13 p refs
Avail: NTIS HC A16/MF A01
The REFEL silicon carbide was developed as a canning material for high temperature nuclear reactor fuel, because of its high temperature stability, its oxidation resistance and its thermal stress and thermal shock resistance, and the reliability of the manufacturing process and the consistency of the product were established at an early stage in the development. The gas turbine engine is analogous to the nuclear reactor in that the same material characteristics are required and fabrication processes have now been developed which enable most gas turbine components to be formed from REFEL silicon carbide effectively and with a minimum of machining. The material is shown to peform satisfactorily in most stator applications and to be superior to other available ceramic materials for combustors. In the properties of REFEL silicon carbide are discussed, the fabrication processes are outlined and some of the published test data is reviewed. J.M.S.

N80-29354# Solar Turbines International, San Diego, Calif.
DEVELOPMENT OF CERAMIC NOZZLE SECTION FOR SMALL RADIAL GAS TURBINE
J. C. Napier and J. P. Arnold *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 10 p refs Prepared in cooperation with Army Mobility Equipment Research and Development

Command, Ft. Belvoir, Va.

Avail: NTIS HC A16/MF A01

Ceramics not only offer improved gas turbine performance through higher turbine inlet temperature but can increase engine life because of improved hot and erosion resistance. Development work leading to engine test of both erosion-resistant and high temperature ceramic nozzle concepts is described. The first nozzle concept employs ceramic vane sections and demonstrated a ten to one-hundred fold hot end life improvement under erosive conditions in engine tests. The second concept was engine demonstrated and offers high erosion resistance as well as the capability of operating at elevated turbine inlet temperatures. Work on ceramics manufacturing methods for cost reduction with the goal of providing economic incentives for ceramics in production turbines is described. Author

N80-29357# Lucas Aerospace Ltd., Burnley (England). Fabrications Dept.

SOME EXPERIENCE IN THE DESIGN AND EVALUATION OF CERAMIC COMBUSTION CHAMBERS

G. Sedgwick *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 15 p refs

Avail: NTIS HC A16/MF A01

The design, component evaluation, and combustion testing of a small reverse flow annular combustion chamber constructed in silicon nitride is reviewed. Initially heat transfer assessments were made of the temperature levels which components would reach during combustion testing and a thermal test program was formulated which enabled loadings well in excess of those estimated for the actual flame tube environment to be imposed upon specimen components. From calculated thermal stresses, values for the probabilities of survival were obtained using a brittle failure analysis based on a Weibull distribution and a volume flow weakest link hypothesis. A subsequent program of combustion tests carried out on a pressure rig culminated in operation at a chamber exit temperature of 1762 K. A pipe combustion chamber program is also described using a monolithic construction in silicon carbide, in which failure modes are presented and analyzed. E.D.K.

N80-29358*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STATE-OF-THE-ART SiAlON MATERIALS

Sunil Dutta *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 15 p refs

Avail: NTIS HC A16/MF A01 CSCL 21E

The state of the art of SiAlONs is examined. The review includes work on phase relations, crystal structure, synthesis, fabrication, and properties of various SiAlONs. The essential features of compositions, fabrication methods, and microstructure are reviewed. High temperature flexure strength, creep, fracture toughness, oxidation, and thermal shock resistance are discussed. These data are compared to those for some currently produced silicon nitride ceramics to assess the potential of SiAlON materials for use in advanced gas turbine engines. E.D.K.

N80-29360# Allmanna Svenska Elektriska A. B., Robertsfors (Sweden). High Pressure Lab.

HIP SILICON NITRIDE

Hans T. Larker *In* AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 4 p refs

Avail: NTIS HC A16/MF A01

Hot isostatic pressing (HIP) is being developed as a manufacturing process for intricately shaped fully dense silicon nitride parts. The process promises to combine the most attractive features of both the reaction bonding and the hot pressing processes. An encapsulation system compatible with silicon nitride under the HIP conditions was developed. Hubs with protruding blades and airfoils with trailing edges as thin as 0.3 mm were made. It is considered feasible to develop the process to high production and to attractive processing costs. E.D.K.

N80-29367*# Grumman Aerospace Corp., Bethpage, N.Y.

ROCKETS FOR SPIN RECOVERY

R. D. Whipple Aug. 1980 70 p refs

(Contract NAS1-15348)

(NASA-CR-159240) Avail: NTIS HC A04/MF A01 CSCL 01C

The potential effectiveness of rockets as an auxiliary means for an aircraft to effect recovery from spins was investigated. The advances in rocket technology produced by the space effort suggested that currently available systems might obviate many of the problems encountered in earlier rocket systems. A modern fighter configuration known to exhibit a flat spin mode was selected. An analytical study was made of the thrust requirements for a rocket spin recovery system for the subject configuration. These results were then applied to a preliminary systems study of rocket components appropriate to the problem. Subsequent spin tunnel tests were run to evaluate the analytical results.. R.K.G.

N80-29368*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SIMULATOR RESULTS OF AN F-14A AIRPLANE UTILIZING AN AILERON-RUDDER INTERCONNECT DURING CARRIER APPROACHES AND LANDINGS Progress Report, Jan. 1979 - Feb. 1980

Wendell W. Kelly and Philip W. Brown May 1980 92 p refs

(NASA-TM-81833) Avail: NTIS HC A05/MF A01 CSCL 01C

A piloted simulator study was conducted to evaluate an aileron rudder interconnect (ARI) control system for the F-14A airplane in the landing configuration. Effects on pilot performance and handling characteristics were investigated. Two ARI configurations were tested and compared to the standard F-14 fleet control system. A nonlinear aerodynamic model of the F-14 was used in conjunction with a six degree of freedom motion base simulator. The evaluation task, which utilized three subject pilots, consistent of a night carrier approach and landing. Both ARI configurations produced improved pilot performance and pilot ratings when compared to the standard control system. Sideslip due to adverse yaw as considerably reduced by the ARI systems and heading control was more stable and precise. Lateral deviation from centerline was reduced during the approach and lateral touchdown dispersion on the carrier deck was reduced with the ARI control systems. Author

N80-29369*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SINGLE-STAGE ELECTROHYDRAULIC SERVOSYSTEM FOR ACTUATING ON AIRFLOW VALVE WITH FREQUENCIES TO 500 HERTZ

John A. Webb, Jr., Oral Mehmed, and Carl F. Lorenzo Aug. 1980 35 p refs

(NASA-TP-1678; E-252) Avail: NTIS HC A03/MF A01 CSCL 01C

An airflow valve and its electrohydraulic actuation servosystem are described. The servosystem uses a high-power, single-stage servovalve to obtain a dynamic response beyond that of systems designed with conventional two-stage servovalves. The electrohydraulic servosystem is analyzed and the limitations imposed on system performance by such nonlinearities as signal saturations and power limitations are discussed. Descriptions of the mechanical design concepts and developmental considerations are included. Dynamic data, in the form of sweep-frequency test results, are presented and comparison with analytical results obtained with an analog computer model is made. R.K.G.

N80-29370# Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.

RESULTS OF A SIMULATOR INVESTIGATION OF CONTROL SYSTEM AND DISPLAY VARIATIONS FOR AN ATTACK HELICOPTER MISSION

Edwin W. Aiken and Robert K. Merrill May 1980 25 p refs Presented at 36th Ann. Natl. Forum of the AHS, Washington, D.C., May 1980

(AD-A085812) Avail: NTIS HC A02/MF A01 CSCL 01/2

A piloted simulator experiment designed to assess the effects on overall system performance and pilot workload of variations

in control system characteristics and display format and logic for a nighttime attack helicopter mission is described. The simulation facility provided a representation of a helmet-mounted display image consisting of flight-control and fire-control symbology superimposed on the background video from a simulated forward-looking infrared sensor. Control systems ranging from the baseline stability and control augmentation system to various hover augmentation schemes were investigated together with variations in the format and logic of the superimposed symbology. Selected control system and display failures were also simulated. The results of the experiment indicate that the baseline control/display system is unsatisfactory without improvement for the evaluation task which included a hovering target search and acquisition. Significant improvements in pilot rating were achieved by both control system and display variations. GRA

N80-29371# Rockwell International Corp., Anaheim, Calif. Autonetics Strategic Systems Div.
FEASIBILITY STUDY B-1 POWER CONTROLLER Final Report, Aug. - Nov. 1979
C. E. Young Warminster, Pa. NADC Nov. 1979 95 p
(Contract N62269-79-C-0294)
(AD-A086166; NADC-79134-60) Avail: NTIS HC A05/MF A01 CSCL 10/2

This report documents the feasibility of modifying and repackaging the Solid State Power Controller (SSPC) developed for the B-1 to meet the performance and configuration requirements for Advanced Aircraft Electrical System (AAES). The effort included an analysis of the applicability of the B-1 monolithic and pass elements, and the application of advance developments to meet the volumetric constraints of NADC-30-TS-7602. GRA

N80-29373# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
OPEN LOOP GUST ALLEVIATION Final Report, Aug. 1978
Manfred Buchstaller, Hugo Kozakiewicz, Rolf Menzl, Wolfgang Reuter, Johannes Schroeder, Siegfried Stauber, and Horst Wuennenberg Bonn Bundesmin. fuer Forsch. u. Technol. Oct. 1979 111 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-79-10) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 22,90

Previous results, the effectiveness of two alternative gust alleviation concepts, and the technical preacticability of an intended test program were examined. The two concepts are a control system using an elevator alone and a combined system of open and closed loop control. The results examined show that a gust alleviation of 30% is possible with the elevator alone while superposition of the open and closed loop principles improves the pure open loop system, especially at higher frequencies. The practicability study shows that there are neither major technical nor certification problems concerning the realization of a flight test program with the DO 28 TNT as a test aircraft. The symmetrical activation of the ailerons as lift flaps can be realized without feedback to the pilot's control column by a central electrically driven actuator within the fuselage. Elevator control is realized by the trimming spindle. In this case there is a certain feedback to the control column. Signal processing is done digitally. Author (ESA)

N80-29374# Aeronautical Research Labs., Melbourne (Australia).
A PROPOSAL FOR AERODYNAMICALLY ACTUATED SELF STREAMLINING SUBSONIC WIND TUNNEL WALLS
N. Pollock Jun. 1979 27 p refs
(ARL-Aero-Note-392; AR-001-739) Avail: NTIS HC A03/MF A01

An arrangement is described which ensures that solid flexible two dimensional subsonic wind tunnel walls will automatically and continuously assume a shape approximating an unconstrained streamline under the action of a model pressure field. Such a tunnel wall would minimize interference. Each wall consists of a streamwise tensioned membrane with a series of pressure tappings. These pressure tappings communicate with a number of flexible bellows which apply appropriate local forces to the membrane. Methods covering the extension of this concept to a three dimensional configuration are also discussed. Author

N80-29375# Naval Civil Engineering Lab., Port Hueneme, Calif.
FIBERGLASS-REINFORCED PLASTIC SURFACING FOR RAPID RUNWAY REPAIR BY NAVAL CONSTRUCTION Interim Report, Nov. 1978 - Apr. 1979
P. S. Springston Oct. 1979 50 p
(YF53536091)
(AD-A085357; CEL-TN-1563) Avail: NTIS HC A04/MF A01 CSCL 13/3

This report documents exploratory research conducted to develop a preliminary concept for repairing bomb damaged runways with prefabricated fiberglass-reinforced plastic membranes. The membranes would function as trafficable caps over backfilled craters. A structural analysis has been completed using the finite element method and a design is presented for a membrane to be traffic-tested under simulated F-4 aircraft wheel loads at the Rapid Runway Repair Test Facility of the Air Force Engineering and Services Center/Research Division at Tyndall AFB, Florida. Methods for joining panels to form large membranes and a tiedown method are discussed. A general concept for rapid runway repair by the Naval Construction Forces using table-of-allowance (P25 and P31) equipment is presented. GRA

N80-29432*# George Washington Univ., Washington, D. C. School of Engineering and Applied Science.
STATISTICAL ASPECTS OF CARBON FIBER RISK ASSESSMENT MODELING
Donald Gross, Douglas R. Miller, and Richard M. Soland Jul. 1980 127 p refs
(Contract NsG-1556)
(NASA-CR-159318) Avail: NTIS HC A07/MF A01 CSCL 11D

The probabilistic and statistical aspects of the carbon fiber risk assessment modeling of fire accidents involving commercial aircraft are examined. Three major sources of uncertainty in the modeling effort are identified. These are: (1) imprecise knowledge in establishing the model; (2) parameter estimation; and (3) Monte Carlo sampling error. All three sources of uncertainty are treated and statistical procedures are utilized and/or developed to control them wherever possible. A.R.H.

N80-29442# Executive Office of the President, Washington, D. C. Office of Science and Technology Policy.
CARBON/GRAPHITE COMPOSITE MATERIAL STUDY Annual Report, 1979
15 Mar. 1980 67 p
(PB80-175235; AR-2) Avail: NTIS HC A04/MF A01 CSCL 11E

Progress is reported by NASA, DOT, DOD, OSHA, and NIOSH in assessing the potential effects of accidentally released carbon fibers on electronic equipment in aircraft, surface vehicles, commercial institutions, and households as well as on power generation and distribution facilities. The impact on municipal solid waste disposal facilities is also considered along with methods for environmental monitoring and for determining health related problems in industries. The modification of carbon/graphite fibers and the use of alternate materials is discussed. A market analysis of U.S. manufacturers is included. A.R.H.

N80-29465# Rockwell International Corp., Anaheim, Calif. Electronics Research Center.
MULTICOLOR ELECTROCHROMIC DOT-MATRIX DISPLAY INVESTIGATION Final Report, 1 Jul. 1979 - 31 Mar. 1980
M. M. Nicholson, F. A. Pizzarello, and T. J. LaChapelle Jun. 1980 51 p refs
(Contract N00014-79-C-0434)
(AD-A085453; C80-325/501) Avail: NTIS HC A04/MF A01 CSCL 07/4

The feasibility of multicolor electrochromic dot-matrix displays based on lutetium diphthalocyanine was investigated on the premise that integrated matrix drive electronics for such devices will become available in several years. A 3 x 3 inch display panel with switchable 5 x 7 dot characters was attractive and

clearly legible at 24 lpi. Viewing was hardly impaired when a metal mesh overlay simulating the appearance of matrix drive circuitry was placed in registry with the dot pattern. Color resolution and memory were demonstrated for adjacent red/green, blue/green, and red/blue areas in the matrix. Current and charge transients were recorded for constant-voltage pulses applied to areas representing 2 to 16 dots. Time constants of 10 to 20 ms were typical of the green-to-red electrochromic transition. An effective capacitance of approximately 1000 microform/sq cm arose from the electrochemical reaction of the dye film. Also associated with that process was an area resistance, usually less than 25 ohms sq cm. Further development of multicolor electrochromic dot-matrix displays is recommended. GRA

N80-29502*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOME ADVANTAGES OF METHANE IN AN AIRCRAFT GAS TURBINE
Robert W. Graham and Arthur J. Glassman 1980 18 p refs Proposed for presentation at Aerospace Congr., Los Angeles, 13-16 Oct. 1980; sponsored by ASAE
(NASA-TM-81559; E-520) Avail: NTIS HC A02/MF A01 CSCL 21D

Liquid methane, which can be manufactured from any of the hydrocarbon sources such as coal, shale biomass, and organic waste considered as a petroleum replacement for aircraft fuels. A simple cycle analysis is carried out for a turboprop engine flying a Mach 0.8 and 10, 688 meters (35,000 ft.) altitude. Cycle performance comparisions are rendered for four cases in which the turbine cooling air is cooled or not cooled by the methane fuel. The advantages and disadvantages of involving the fuel in the turbine cooling system are discussed. Methane combustion characteristics are appreciably different from Jet A and will require different combustor designs. Although a number of similar difficult technical problems exist, a highly fuel efficient turboprop engine burning methane appear to be feasible. A.R.H.

N80-29543*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
COMPLEMENTARY CROSS-SLOT PHASED ARRAY ANTENNA Patent Application
Haynes Ellis, Jr., inventor (to NASA) (Rockwell International Corp., Downey, Calif.) Filed 25 Jul. 1980 14 p Sponsored by NASA
(NASA-Case-MSC-18532-1; US-Patent-Appl-SN-172099) Avail: NTIS HC A02/MF A01 CSCL 09C

A flush mounting, cavity-backed, dual orthogonal slot antenna is described in which improved radiation pattern characteristics are obtained by making the spiral slot pattern elliptical in the aperture plane. Coaxial split-tube baluns are used to drive the junctions between corresponding slot pairs. Optional cavity dielectric is provided and a drive coupling arrangement includes a four port compartor hybrid having sum and difference ports respectively, for alternate excitation to produce a single lobe or a double lobe pattern with null. Switching appratus is provided to connect a common terminal to either of the ports. NASA

N80-29565# Arinc Research Corp., Annapolis, Md.
FAA COMMUNICATIONS COST MODEL PROGRAM DOCUMENTATION: REVISED
W. Kolb, R. Tanke, and I. Gershkoff Apr. 1980 88 p
(Contract DOT-FA77WA-4018)
(AD-A086020; Rept-1339-01-702174-Rev; FAA-ASP-80-7) Avail: NTIS HC A05/MF A01 CSCL 17/2

The FAA Communications Cost Model is a computer program designed to answer management questions dealing with long-term, national-level communications planning issues. Therefore, the program is purposely directed toward estimating long-term macro-level (as opposed to near-term, micro-level) communications costs. The algorithms used emphasize cause-and-effect relationships (rather than direct extrapolation of cost data) to predict costs. This report documents the communications model computer program. It includes a description of model equations, functional flow charts, and the program listings. It should be used in conjunction with the revised FAA Communications Model User's Guide for a comprehensive understanding of the computer software. The edition supersedes the issue dated May 1979. GRA

N80-29568# National Aviation Facilities Experimental Center, Atlantic City, N. J.
EVALUATION OF THE AVIATION WEATHER AND NOTAM SYSTEM (AWANS) Final Report, Aug. 1975 - Sep. 1976
Hugh D. Milligan and Bruce L. Rosenberg Jun. 1979 51 p
(AD-A086167; FAA-NA-79-13; FAA-RD-79-46) Avail: NTIS HC A04/MF A01 CSCL 17/2

This activity was conducted to ascertain the operational effectiveness of an experimental system in providing automation capabilities geared to flight service station application. Primary consideration was given to the man-machine relationship and the efficacy of the data and presentation formats made available to the specialist through the system. Maintenance, technical, and software aspects were not specifically addressed. Results of the study indicate that the automated system provides textual and graphic data in a form suitable for use in preflight and in-flight briefing modes. Further, the equipment configurations under study contained one which was acceptable, though not deemed optimal, by the specialists. This acceptability included the display size, character size and font, graphic and textual products, communications equipment, console design, and associated equipment layout. GRA

N80-29594# Siemens-Allis, Inc., Portland, Oreg.
ICE-RELEASE COATING FOR DISCONNECT SWITCHES Final Report
J. L. Mundon Mar. 1980 42 p Sponsored by Electric Power Research Inst.
(EPRI-EL-1330) Avail: NTIS HC A03/MF A01

Several coatings for ice release, heat dissipation, thermal cycling, and outdoor weathering properties were evaluated. The coating having the most desired performance were applied to full scale switch components. The full scale switches were tested for ice performance and heat dissipation and the results were compared with those on identical switches with uncoated components. The coating chosen for application to switch components was installed on several switches for field evaluation during the winter of 1979 and 1980. It was offered for commercial application for installation to existing switch installations. Results indicate that the coating also exhibits excellent heat dissipation properties and may be used to improve heat dissipation of switch blades and other components. The coating material is unaffected by sunlight; it is a two component, Teflon-filled polyurethane that is available from two sources. The material is currently used for a variety of purposes, such as: aircraft wing and leading edge areas, hydrofoils, conveyor chutes and many others. Light gray in color, it is an excellent heat dissipator and matches the gray insulators used with most switches. DOE

N80-29595# Texas Univ. at Austin. Center for Electromechanics.
DETAILED DESIGN, FABRICATION AND TESTING OF AN ENGINEERING PROTOTYPE COMPENSATED PULSED ALTERNATOR Final Report
W. L. Bird, Jr. and Herbert H. Woodson Mar. 1980 211 p refs
(Contract W-7405-eng-48)
(UCRL-15213) Avail: NTIS HC A10/MF A01

The design, fabrication, and test results of a prototype compensated pulsed alternator are discussed. The prototype compulsator is a vertical shaft single phase alternator with a rotating armature and salient pole stator. The machine is designed for low rep rate pulsed duty and is sized to drive a modified 10 cm Beta amplifier. The load consists of sixteen 15 mm x 20 mm x 112 cm long xenon flashlamps connected in parallel. The prototype compulsator generates an open circuit voltage of 6 kV, 180 Hz, at a maximum design speed of 5400 rpm. At maximum speed, the inertial energy stored in the compulsator rotor is 3.4 megajoules. DOE

N80-29613 Georgia Inst. of Tech., Atlanta.
AN INTEGRAL-REPRESENTATION APPROACH FOR TIME-DEPENDENT VISCOUS FLOWS Ph.D. Thesis
Yehia M. Attia Rizk 1980 163 p
Avail: Univ. Microfilms Order No. 8018156

Numerical solutions for the laminar, incompressible flow around a two dimensional solid body are developed and presented. The equations of motion are formulated in the unsteady form. The body is assumed to impulsively start and the desired solution is obtained by forward marching in time. The present scheme is based on portioning the problem into a kinematic part and a kinetic part through the use of the vorticity and velocity as the dependent variables. The flow field is divided into two regions; an inner region immediately adjacent to the body and an outer region far from the body. An integral relation for the kinetic part is developed and it is combined with an available integral relation for the kinematic part to solve for the vorticity and velocity in the inner region. Finite differences techniques are used to solve the equations of motion in the outer region. The validity of the method is demonstrated by solving the flow over a flat plat at zero angle of attack and the flow around a circular cylinder. The numerical results obtained from the method are compared with available data and other numerical solutions. Dissert. Abstr.

N80-29710*# Ingersoll-Rand Co., Easton, Pa.
ANALYSIS AND IDENTIFICATION OF SUBSYNCHRONOUS VIBRATION FOR A HIGH PRESSURE PARALLEL FLOW CENTRIFUGAL COMPRESSOR
R. G. Kirk, J. C. Nicholas, G. H. Donald, and R. C. Murphy *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 45-63 refs

Avail: NTIS HC A20/MF A01 CSCL 13I

The summary of a complete analytical design evaluation of an existing parallel flow compressor is presented and a field vibration problem that manifested itself as a subsynchronous vibration that tracked at approximately 2/3 of compressor speed is reviewed. The comparison of predicted and observed peak response speeds, frequency spectrum content, and the performance of the bearing-seal systems are presented as the events of the field problem are reviewed. Conclusions and recommendations are made as to the degree of accuracy of the analytical techniques used to evaluate the compressor design. M.G.

N80-29711*# Allis-Chalmers Mfg. Co., Milwaukee, Wis.
SUBSYNCHRONOUS INSTABILITY OF A GEARED CENTRIFUGAL COMPRESSOR OF OVERHUNG DESIGN
J. H. Hudson and L. J. Wittman *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 67-83 refs

Avail: NTIS HC A20/MF A01 CSCL 13I

The original design analysis and shop test data are presented for a three stage (poster) air compressor with impellers mounted on the extensions of a twin pinion gear, and driven by an 8000 hp synchronous motor. Also included are field test data, subsequent rotor dynamics analysis, modifications, and final rotor behavior. A subsynchronous instability existed on a geared, overhung rotor. State-of-the-art rotor dynamics analysis techniques provided a reasonable analytical model of the rotor. A bearing modification arrived at analytically eliminated the instability.M.G.

N80-29712*# Bently Nevada Corp., Minden.
THE PARAMETERS AND MEASUREMENTS OF THE DESTABILIZING ACTIONS OF ROTATING MACHINES, AND THE ASSUMPTIONS OF THE 1950'S
Donald E. Bently *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 95-106
Avail: NTIS HC A20/MF A01 CSCL 13I

The measurability of destabilizing actions is demonstrated for a rotor built to produce a forward circular, self excited malfunction (gas whip). It is argued that the continued use of past modeling technqiues is unfortunate in that it has led to the use of inappropriate words to express what is happening and a lack of full understanding of the category of forward circular whip instability mechanisms. M.G.

N80-29713*# Kobe Steel Ltd. (Japan).
ASYNCHRONOUS VIBRATION PROBLEM OF CENTRIFUGAL COMPRESSOR
Takeshi Fujikawa, Naotsugi Ishiguro, and Mitsuhiko Ito *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 109-118 refs

Avail: NTIS HC A20/MF A01 CSCL 13I

An unstable asynchronous vibration problem in a high pressure centrifugal compressor and the remedial actions against it are described. Asynchronous vibration of the compressor took place when the discharge pressure (Pd) was increased, after the rotor was already at full sppeed. The typical spectral data of the shaft vibration indicate that as the pressure Pd increases, pre-unstable vibration appears and becomes larger, and large unstable asynchronous vibration occurs suddenly (Pd = 5.49MPa). A computer program was used which calculated the logarithmic decrement and the damped natural frequency of the rotor bearing systems. The analysis of the log-decrement is concluded to be effective in preventing unstable vibration in both the design stage and remedial actions. M.G.

N80-29715*# Kobe Univ. (Japan). Engineering Dept.
EVALUATION OF INSTABILITY FORCES OF LABYRINTH SEALS IN TURBINES OR COMPRESSORS
Tkuakuzo Iwatsubo *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 139-167 refs
Avail: NTIS HC A20/MF A01 CSCL 13I

The effects of a force induced by the labyrinth seal on the stability of rotor systems and the factors of the seal which affect the stability are investigated. In the analysis, it is assumed that the fluid in the seal is steady and that the rotor is set vertically in order to avoid the effects of gravity force. The force induced by the seal is expressed in terms proportional to the velocity and displacement of the rotor and is deduced to that expression for the oil film force in journal bearings. That force is taken into account in the equations of motion; then the stability of the system is discussed by energy concept. The force induced by the labyrinth seal always makes the rotor system unstable, and the tendency is marked when seal leakages are small. The resonance point of the rotor system is also affected by the labyrinth seal (the resonance point of the rotor system is removed by the seal leakages). The force induced by the labyrinth seal was measured by using a water-tunnel experimental system which was designed to measure the labyrinth seal force by using the similarity between gas and liquid flow theory. M.G.

N80-29716*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DAMPING IN RING SEALS FOR COMPRESSIBLE FLUIDS
David P. Fleming *In its* Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 169-188 refs

Avail: NTIS HC A20/MF A01 CSCL 13I

An analysis is presented to calculate damping in ring seals for a compressible fluid. Results show that damping in tapered ring seals (optimized for stiffness) is less than that in straight bore ring seals for the same minimum clearance. Damping in ring seals can promote fractional frequency whirl and can, thus, be detrimental. Thus, tapered seals can benefit rotor and seal stability by having lower damping as well as higher stiffness. Use of incompressible results leads to large errors. Author

N80-29717*# Stuttgart Univ. (West Germany). Institut fuer Thermische Stroemungsmaschinen.
FLOW INDUCED SPRING COEFFICIENTS OF LABYRINTH SEALS FOR APPLICATION IN ROTOR DYNAMICS
H. Benckert and J. Wachter *In* NASA. Lewis Res. Center Rotodyn. Instability Probl. in High-Performance Turbomachinery 1980 p 189-212 refs

Avail: NTIS HC A20/MF A01 CSCL 13I

Flow induced aerodynamic spring coefficients of labyrinth seals are discussed and the restoring force in the deflection plane of the rotor and the lateral force acting perpendicularly to it are also considered. The effects of operational conditions on the spring characteristics of these components are examined, such as differential pressure, speed, inlet flow conditions, and the geometry of the labyrinth seals. Estimation formulas for the lateral forces due to shaft rotation and inlet swirl, which are developed through experiments, are presented. The utilization of the investigations is explained and results of stability calculations, especially for high pressure centrifugal compressors, are added. Suggestions are made concerning the avoidance of exciting forces in labyrinths. M.G.

N80-29720*# Technical Univ. of Denmark, Copenhagen.
EFFECT OF FLUID FORCES ON ROTOR STABILITY OF CENTRIFUGAL COMPRESSORS AND PUMPS
Jorgen Colding-Jorgensen *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 249-265 refs
Avail: NTIS HC A20/MF A01 CSCL 13I

A simple two dimensional model for calculating the rotordynamic effects of the impeller force in centrifugal compressors and pumps is presented. It is based on potential flow theory with singularities. Equivalent stiffness and damping coefficients are calculated for a machine with a vaneless volute formed as a logarithmic spiral. It is shown that for certain operating conditions, the impeller force has a destablizing effect on the rotor. R.C.T.

N80-29721*# Cornell Univ., Ithaca, N. Y.
NON-SYNCHRONOUS WHIRLING DUE TO FLUID-DYNAMIC FORCES IN AXIAL TURBO-MACHINERY ROTORS
Shan Fu Shen and Vinod G. Mengle *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 267-284 refs

Avail: NTIS HC A20/MF A01 CSCL 13I

The role of fluid forces acting on the blades of an axial turborotor with regards to whirling was analyzed. The dynamic equations were formulated for the coning mode of an overhung rotor. The exciting forces due to the motion were defined through a set of rotor stability derivatives, and analytical expressions of the aerodynamic contributions were found for the case of small mean stream deflection, high solidity and equivalent flat plate cascade. For a typical case, only backward whirl was indicated when the phase shifting of the rotor wake effect was ignored. A parametric study of the dynamic stability boundary reveals that a reduction in blade stagger angle, mass flow rate, fluid density and an increase in stiffness and external damping are all inducive for improved stability. R.C.T.

N80-29724*# Tokyo Univ. (Japan).
FLUID FORCES ON ROTATING CENTRIFUGAL IMPELLER WITH WHIRLING MOTION
Hidenobu Shoji and Hideo Ohashi *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 317-328 refs Sponsored in part by the Japanese Ministry of Education and by Hitachi Ltd.

Avail: NTIS HC A20/MF A01 CSCL 13I

Fluid forces on a centrifugal impeller, whose rotating axis whirls with a constant speed, were calculated by using unsteady potential theory. Calculations were performed for various values of whirl speed, number of impeller blades and angle of blades. Specific examples as well as significant results are given. R.C.T.

N80-29731*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
STABILIZATION OF AERODYNAMICALLY EXCITED TURBOMACHINERY WITH HYDRODYNAMIC JOURNAL BEARINGS AND SUPPORTS
Lloyd E. Barrett and Edgar J. Gunter *In* NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 429-452 refs

(Grant NsG-3105; Contracts DAAG29-77-C-0009; EF-76-S-01-2479)
Avail: NTIS HC A20/MF A01 CSCL 13I

A method of analyzing the first mode stability and unbalance response of multimass flexible rotors is presented whereby the multimass system is modeled as an equivalent single mass modal model including the effects of rotor flexibility, general linearized hydrodynamic journal bearings, squeeze film bearing supports and rotor aerodynamic cross coupling. Expressions for optimum bearing and support damping are presented for both stability and unbalance response. The method is intended to be used as a preliminary design tool to quickly ascertain the effects of bearing and support changes on rotor-bearing system performance. R.C.T.

N80-29767*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPLICATION OF FULLY STRESSED DESIGN PROCEDURES TO REDUNDANT AND NON-ISOTROPIC STRUCTURES
Howard M. Adelman, Raphael T. Haftka, and Uri Tsach Jul. 1980 35 p refs
(NASA-TM-81842) Avail: NTIS HC A03/MF A01 CSCL 20K

An evaluation is presented of fully stressed design procedures for sizing highly redundant structures including structures made of composite materials. The evaluation is carried out by sizing three structures: a simple box beam of either composite or metal construction; a low aspect ratio titanium wing; and a titanium arrow wing for a conceptual supersonic cruise aircraft. All three structures are sized by ordinary fully-stressed design (FSD) and thermal fully stressed design (TFSD) for combined mechanical and thermal loads. Where possible, designs are checked by applying rigorous mathematical programming techniques to the structures. It is found that FSD and TFSD produce optimum designs for the metal box beam, but produce highly non-optimum designs for the composite box beam. Results from the delta wing and arrow wing indicate that FSD and TFSD exhibits slow convergence for highly redundant metal structures. Further, TFSD exhibits slow oscillatory convergence behavior for the arrow wing for very high temperatures. In all cases where FSD and TFSD perform poorly either in obtaining nonoptimum designs or in converging slowly, the assumptions on which the algorithms are based are grossly violated. The use of scaling, however, is found to be very effective in obtaining fast convergence and efficiently produces safe designs even for those cases when FSD and TFSD alone are ineffective. Author

N80-29911*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECTS OF CONVERSATION INTERFERENCE ON ANNOYANCE DUE TO AIRCRAFT NOISE
Kelli F. Key and Clemans A. Powell Aug. 1980 38 p refs
(NASA-TP-1712; L-13709) Avail: NTIS HC A03/MF A01 CSCL 13B

The annoyance and interference effects of aircraft flyover noise on face to face conversation were investigated. Twenty 5 minute sessions, each composed of three flyovers, were presented to each of 20 pairs of female subjects in a simulated living room. Flyovers varied in peak noise level (55-79 dB, A-weighted) and spectrum (low or high frequency components). Subjects engaged in conversation for 10 sessions and in reverie for the other 10 sessions, and completed subjective ratings following every session. Annoyance was affected by noise level, but was not significantly different for the two activities of reverie and conversation. A noise level of 77 db was found unacceptable for conversation by 50 percent of the subjects. Conversation interference was assessed by incidence of increased vocal effort and/or interruption of conversation during flyovers. Although conversation interference increased with noise level, the conversation interference measures did not improve prediction of individual annoyance judgments. Author

N80-29921# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.
ADVANCED COMBUSTION SYSTEMS FOR STATIONARY GAS TURBINE ENGINES. VOLUME 1: REVIEW AND PRELIMINARY EVALUATION Final Report, Dec. 1975 - Sep. 1976
Stanley A. Mosier and Robert M. Pierce Jan. 1980 49 p refs 2 Vol.
(Contract EPA-68-02-2136)
(PB80-175599; FR-11405-Vol-1; EPA-600/7-80-017A-Vol-1)
Avail: NTIS HC A03/MF A01 CSCL 13B

Duty cycles were analyzed to identify current and projected dominant operating modes and requirements of stationary gas turbine engines. These analyses indicate that as compression ratios and turbine inlet temperatures are increased to improve thermal efficiency, uncontrolled NOx emissions can be expected to double in 10 years and triple in 20 years. An extensive survey was made of candidate combustor concepts, and an analytical study was made from which those concepts considered to have significant potential for reducing production of NOx were identified. An initial compilation of 26 combustor design concepts was assembled, indicating potential for controlling NOx from clean fuels and/or fuels containing significant amounts of bound nitrogen. GRA

N80-29922# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.
ADVANCED COMBUSTION SYSTEMS FOR STATIONARY GAS TURBINE ENGINES. VOLUME 2: BENCH SCALE EVALUATION Final Report, Sep. 1976 - Jan. 1978
Robert M. Pierce, Stanley A. Mosier, Clifford E. Smith, and B. S. Hinton Jan. 1980 384 p ref 2 Vol.
(Contract EPA-68-02-2136)
(PB80-175607; FR-11405-Vol-2; EPA-600/7-80-017B-Vol-2)
Avail: NTIS HC A16/MF A01 CSCL 13B

Results from the testing program identified two design approaches capable of significant emission reduction. A staged centertube design, relying on burner operation near the lean blowout limit, gave low NOx and CO emissions on clean no. 2 fuel oil, but was ineffective for fuels containing bound nitrogen. A rich-burn/quick-quench (RB/QQ) design, producing a fuel-rich primary zone and quickly quenching the effluent from that region to the high overall excess air conditions required by the gas turbine cycle, successfully controls NOx from both thermal and fuel-bound sources while maintaining low CO emissions for high thermal efficiency. The RB/QQ concept was selected for scaleup to full size hardware. GRA

N80-29961 Tennessee Univ., Knoxville.
ATMOSPHERIC TURBULENCE SIMULATION TECHNIQUES WITH APPLICATION TO FLIGHT Ph.D. Thesis
Show-Tien Wang 1980 173 p
Avail: Univ. Microfilms Order No. 8018503

Statistical modeling of atmospheric turbulence is discussed. The statistical properties of atmospheric turbulence, in particular the probability distribution, the spectra, and the coherence are reviewed. Different atmospheric turbulence simulation models are investigated and appropriate statistical analyses are carried out to verify their validity. The models for simulation are incorporated into a computer model of aircraft flight dynamics. Statistical results of computer simulated landings for an aircraft having characteristics of a DC-8 are reported for the different turbulence simulation techniques. The significance of various degrees of sophistication in the turbulence simulation techniques on the landing performance of the aircraft is discussed. Dissert. Abstr.

N80-30013# Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
HUMAN FACTORS IN HIGH-SPEED LOW-LEVEL ACCIDENTS: A 15 YEAR REVIEW
R. C. Rud and D. F. Leben *In* AGARD High-Speed, Low-Level Flight Mar. 1980 6 p refs

Avail: NTIS HC A14/MF A01

The Canadian Forces introduced the CF 104G into Squadron Operation in 1963 and since that time these aircraft have operated in the high speed, low level environment in both the strike/reconnaissance and tactical support roles. Fifty seven accidents involving these aircraft are reviewed with regard to cause factors. Marginal weather appears to be the one most significant factor contributing to low level, high speed accidents; however, several human factors such as visual contrast problems, fatigue, stress, reaction time, mission completion syndrome, inattention, and task overload were identified. Aspects of accidents which typify human factors problems are described. Suggested possible preventive measures are outlined. E.D.K.

N80-30015# Bureau of Medicine and Surgery (Navy), Washington, D. C.
NAVAL AVIATION WATER SURVIVAL PROGRAM
Wilton McIntosh *In* AGARD High-Speed, Low-Level Flight Mar. 1980 3 p refs

Avail: NTIS HC A14/MF A01

The very nature of naval aviation requires that the majority of operation flights be conducted overwater. The missions vary from operations in the immediate vicinity of aircraft carriers and shore bases to single aircraft flights hundreds of miles form the nearest land. Each situation presents unique problems in terms of required survival equipment and length of time to rescue. Major revisions to the Naval Aviation Water Survival Program are presently underway. The Training curricula are being standardized and water survival instructors are to be extensively trained to conduct the training. Aviation life support systems are being modified to provide automatic life preserver inflation and parachute divestment. New water training devices are being procured and training is to be conducted in the devices with the same configuration of life support equipment with which the aircrew members fly. E.D.K.

N80-30016# Martin-Baker Aircraft Co. Ltd., Denham (England).
HIGH-SPEED, LOW-LEVEL FLIGHT SURVIVAL ON EJECTION
M. A. A. Hobbs *In* AGARD High-Speed, Low-Level Flight Mar. 1980 2 p
Avail: NTIS HC A14/MF A01

The history of work on high speed low level ejection is presented. Current bay practices and a look into the future are also discussed. E.D.K.

N80-30017# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
MINIMIZING THE SEQUENCED DELAY TIME FOR ESCAPE FROM HIGH-SPEED, LOW-LEVEL FLIGHT PROFILES
James H. Raddin, Jr., Lawrence J. Specker, and James W. Brinkley *In* AGARD High-Speed, Low-Level Flight Mar. 1980 12 p refs
Avail: NTIS HC A14/MF A01

The time delay that occurs between the actuation of an escape system and the actual initiation of the ejection catapult acceleration separate the crew from an aircraft is one of the critical factors in the design of escape systems for high speed low level (HSLL) flight conditions. This delay may preclude what could otherwise be a successful escape from certain HSLL profiles. The purpose of this paper is to examine the significance of current operational delay times and describe techniques to minimize the delays. Operational through-the-canopy ejection data are presented to assess the risk of injury incurred in eliminating the delay time altogether. Experimental data from tests with human volunteers are presented to demonstrate the potential for significantly reducing the time required for upper torso retraction. Finally the implications of available aeromedical evidence are elevated in the definition of the most promising approaches to minimize the time required for a HSLL escape sequence. E.D.K.

N80-30020# Department of the Air Force, Edwards AFB, Calif. F-16 Combined Test Force.
THE OPERATIONAL ROLES OF THE F-16
Robert C. Ettinger *In* AGARD Operational Roles, Aircrew Systems and Human Factors in Future High Performance Aircraft Mar. 1980 18 p

Avail: NTIS HC A05/MF A01

The F-16 weapons system is described from its design features to its cockpit displays and controls. The multirole capacity of the F-16 is illustrated by description of the weapons delivery systems, aircraft performance, and weapons carriage capability. Typical operational missions from NATO bases in F-16 European participating countries over Central and Northern Europe are discussed in detail. E.D.K.

N80-30021# French Air Force, Paris. Bureau des Programmes de Materiel.

OPERATIONAL MISSIONS AND CONCEPTUAL DESIGN OF THE MIRAGE 2000

Jacques Guillou *In* AGARD Operational Roles, Aircrew Systems and Human Factors in Future High Performance Aircraft Mar. 1980 5 p In FRENCH

Avail: NTIS HC A05/MF A01

The Mirage 2000 program was established to assure the replacement of all versions of the Mirage 2 aircraft. Intended for defense and aerial superiority, the first Mirage 2000 version must have the capability to intercept hostile bodies at very high altitude, to destroy hostile bodies penetrating at low altitude, and to engage in close combat with weapons equal to those on the test pursuit aircraft of its generation. The SNECMA M 53 engine will be used with a delta wing configuration and electric flight controls. The capacity for maneuverability of the Mirage 2000 marks a fundamental progress in relation to the preceeding aircraft and will lead to new combat techniques.

Transl. by A.R.H.

N80-30022# Royal Air Force, London (England).

THE CAPABILITIES AND OPERATIONAL ROLES OF ROYAL AIR FORCE TORNADOES

H. M. Archer *In* AGARD Operational Roles, Aircraft Systems and Human Factors in Future High Performance Aircraft Mar. 1980 6 p

Avail: NTIS HC A05/MF A01

The concept of producing a multirole aircraft designed to meet the complexities of a number of roles was reached only after extensive computer analysis had shown the way ahead. For the RAF, the air-to-ground task and the air-to-air task calls for differing operating capabilities, but Tornado can meet these requirements. In its IDS version, the aircraft is able to effectively carry out the roles of counter-air, interdiction, close air support, maritime attack, and reconnaissance. Moreover, it is able to do so at very high speed and very low altitude, regardless of weather. The ADV on the other hand uses its powerful long range multitarget radar, advanced avionics with computerized mission planning, and automatic attack features, together with its missile armament, to make it the most effective interceptor available for the air defence of the UK's large strategic area. Backing this very wide range of capabilities, is a comprehensive maintenance system of support, designed from the outset to optimize fault diagnosis, and keep the aircraft ready to fly with the minimum delay. E.D.K.

N80-30061*# Colorado Univ. at Boulder.

FLIGHT SOFTWARE REQUIREMENTS AND DESIGN SUPPORT SYSTEM Final Report

William E. Riddle and Bryan Edwards Aug. 1980 18 p

(Grant NsG-1638)

(NASA-CR-163425) Avail: NTIS HC A02/MF A01 CSCL 09B

The desirability and feasibility of computer-augmented support for the pre-implementation activities occurring during the development of flight control software was investigated. The specific topics to be investigated were the capabilities to be included in a pre-implementation support system for flight control software system development, and the specification of a preliminary design for such a system. Further, the pre-implementation support system was to be characterized and specified under the constraints that it: (1) support both description and assessment of flight control software requirements definitions and design specification; (2) account for known software description and assessment techniques; (3) be compatible with existing and planned NASA flight control software development support system; and (4) does not impose, but may encourage, specific development technologies. An overview of the results is given. R.K.G.

N80-30155*# Boeing Commercial Airplane Co., Seattle, Wash.

ANALYTICAL INVESTIGATION OF FAN TONE NOISE DUE TO INGESTED ATMOSPHERIC TURBULENCE Final Report

Ulrich W. Ganz Washington, D.C. NASA Aug. 1980 151 p refs

(Contract NAS1-15085)

(NASA-CR-3302) Avail: NTIS HC A08/MF A01 CSCL 20A

The atmospheric turbulence involved in the fan noise generation is evaluated with an existing model for the atmospheric turbulence and an extended version of an existing model concerned with the effects of a flow contraction on convected turbulence. Fan tone noise due to ingested atmospheric turbulence is evaluated with existing fan noise models. The results indicate that the difference in fan narrowband noise due to atmospheric turbulence between static and flight landing approach conditions is in the order of 30 dB. It is concluded that fan noise due to atmospheric turbulence is insignificant in flight conditions for the fans used in the current high bypass ratio engines. The difference in fan narrowband noise between the two conditions is primarily due to the low intensity of the turbulence involved in fan noise generation in flight conditions. Fan noise due to atmospheric turbulence in static conditions should be reduced below the flight fan broadband noise levels which is best achieved with a reduction in the intensity of the fan inflow turbulence. Such a reduction can be obtained with the use of an inflow control device, low wind velocities, small surface roughness in the test stand environment, and large engine axis height above the ground. Peak sound power levels for fan tone noise due to ingested turbulence occur for transverse integral scales in the order of 25% of the rotor blade spacing in the fan tip region. Author

N80-30156# Federal Aviation Administration, Washington, D. C. Office of Environment and Energy.

INM INTEGRATED NOISE MODEL, VERSION 2: PROGRAMMER'S GUIDE

Thomas Connor and Robert Hinckley Sep. 1979 130 p Supersedes FAA-EQ-78-03

(Contract DOT-PPA-FA-865)

(AD-A079622; FAA-AEE-79-10; FAA-EQ-78-03) Avail: NTIS HC A07/MF A01 CSCL 20/1

This document contains information on the procedures to implement the Integrated Noise Model (INM), Version 2 into a computer system. The INM is a collection of computer programs which can calculate the aircraft noise environment in the vicinity of an airport. The INM is available from the FAA in the form of a magnetic tape. INM Version 2 supersedes Version 1 which was released in January 1978. This document replaces FAA Integrated Noise Model, Version 1, Computer Installation Instructions: (Report No. FAA-EQ-78-03). GRA

N80-30157# Wyle Labs., Inc., El Segundo, Calif.

CORRECTION PROCEDURES FOR AIRCRAFT NOISE DATA. VOLUME 4: TONE PERCEPTION Final Report

D. N. May and E. E. Watson Feb. 1980 75 p refs

(Contract DOT-FA78WA-4143)

(AD-A083075; WR-79-9-Vol-4; FAA-EE-80-1-Vol-4) Avail: NTIS HC A04/MF A01 CSCL 20/1

The existing tone correction procedure in the Effective Perceived Noise Level (EPNL) calculation procedure required for aircraft certification under Part 36 of the Federal Aviation Regulations was compared with other tone correction procedures, including the SAE Aerospace Recommended Practice 1071 and a multitone procedure due to Kryter and Pearsons. Different amounts of tone correction (level-weightings) and varying degrees of tone correction at different times in the flyover (time-weightings) were also explored. Also studied was a measure of spectral fluctuation, developed by NASA and known as spectral change. The research was limited to considering revisions within the framework of one-third octave, 0.5 second interval

analysis, since such revisions can be quite easily implemented. The various tone correction noise metrics were tested against subjective judgements furnished by NASA of the noise from a range of propjet, turbojet, low and high bypass ratio turbofan, and supersonic commercial aircraft. It was found that a revision based on spectral change could, after further development, be a means to improve the accuracy of the EPNL metric. However, the success of the various other potential revisions depended on the characteristics of the data base tested. It was shown that research into improved metrics should be based on experimental plans which account for the correlations among the noise variables and the presence of any interactions. A separate, psychoacoustical pilot experiment was also performed into the effects of pseudotones on judged noisiness. (Pseudotones are low frequency tones introduced into a measured spectrum by ground reflections near the microphone. GRA

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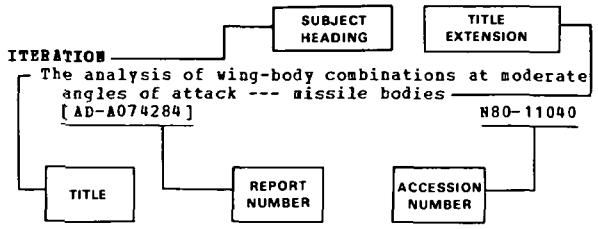

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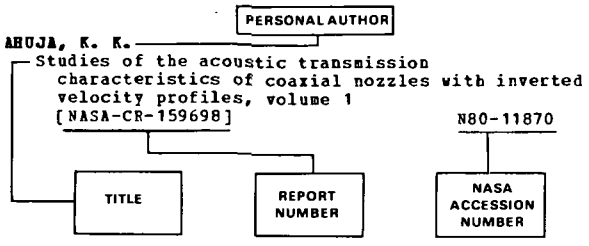

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